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Nebraska's Wetlands: Their Wildlife and Ecology

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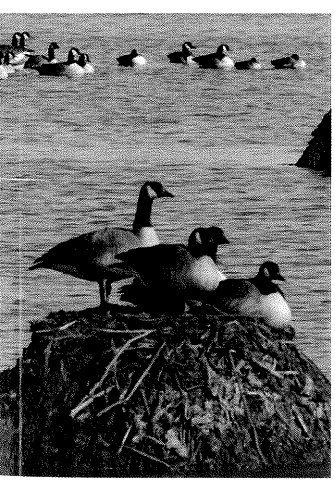

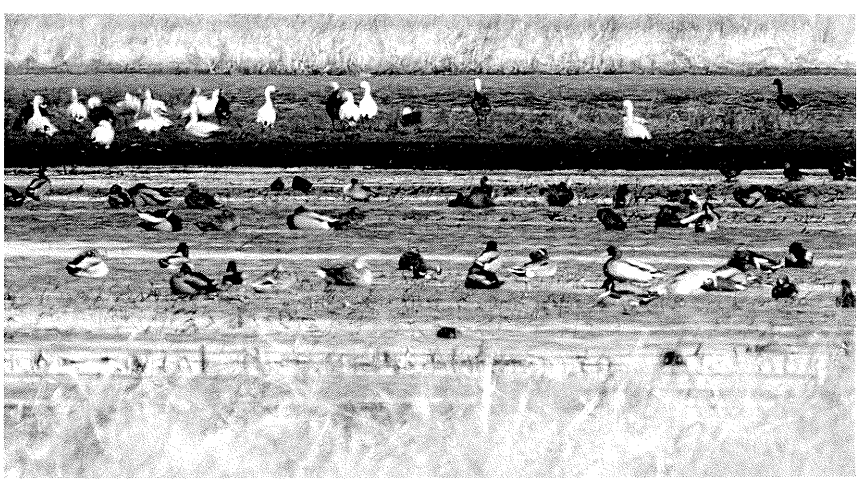

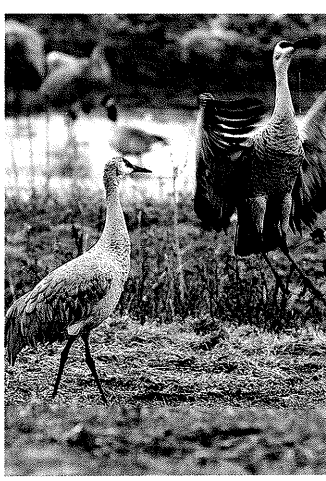

Paul A. Johnsgard
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Nebraska Water Survey Paper Number 78

Conservation and Survey Division
School of Natural Resources
Institute of Agriculture and Natural Resources
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On The Cover

Photographs by Paul A. Johnsgard. Top: Two American white pelicans taking off from a Sandhills wetland in Cherry County. Lower left, Canada geese on a muskrat house, Hamilton County; lower middle, snow geese, mallards and northern pintails on a temporary wetland, Fillmore County; lower right, sandhill cranes dancing beside a temporary wetland, Hall County

Nebraska's Wetlands:
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by
Paul A. Johnsgard
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The Conservation and Survey Division (CSD) of the University of Nebraska-Lincoln is the agency designated by statute to investigate and interpret the geologically related natural resources of the state, to make available to the public the results of these investigations, and to assist in the development and conservation of these resources. It consists of program areas in geology, water, soils, and remote sensing-geographic information systems.

The CSD is authorized to enter into agreements with federal and state agencies to engage in cooperative surveys and investigations of the State. Publications of the CSD and the cooperating agencies are available through the Nebraska Maps & More Store, 101 Hardin Hall, University of Nebraska-Lincoln, Lincoln, NE 68583-0961. Contact the address above, phone: (402) 472-3471, http://nebraskamaps.unl.edu or e-mail snrsales@unl.edu. The CSD web site is: http://snr.unl.edu/csd/.

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About The Author

Paul A. Johnsgard is Foundation Professor of Biological Sciences Emeritus, having taught at the University of Nebraska-Lincoln from 1961 to 2001. He was the first University of Nebraska faculty member to win all three of the University's major faculty awards, the Distinguished Teaching Award, the Outstanding Research and Creative Activity Award, and a Regent's Foundation Professorship. He received an Honorary Doctor of Science degree from the University of Nebraska in 2010.

In 2012 he published his 56th book. These books and related biological publications total some three million words, making him by far the most prolific writer of non-fiction in Nebraska's history, and also the world's most prolific author of ornithological literature. His writing include ten world monographs of bird families, six monographs on North American bird groups, and ten books on the ecology and natural history of Nebraska and the Great Plains. Besides his ornithological writing, he received the Mari Sandoz Award, given by the Nebraska Library Association in 1984 for contributions to the literature of Nebraska, and the Loren Eiseley Award in 1988, given for writings that blend science with humanism. In 2005 he received the received the National Wildlife Federation's National Conservation Achievement Award (Science), and in 2008 was given the Charles H. Callahan Award from the National Audubon Society, the highest honor that they bestow for volunteer conservation work. In 2012 he received the Ralph W. Schreiber Conservation Award from the American Ornithologists' Union for extraordinary scientific contributions to the conservation, restoration or preservation of birds or their habitats."

He was honored by the Lincoln Journal Star (July 15, 1999) as one of "100 people who have helped build Nebraska...the past 100 years," and was also chosen by the Omaha World Herald (Nov. 29, 1999) as one of 100 "Extraordinary Nebraskans" of the past century. Only six persons then still alive were included in both lists.

Chapter 1

An Overview of Nebraska's Wetland Types

Probably most people don't immediately think of wetlands when they think of Nebraska; a friend recently commented to me that my planned book with the prospective title "Wetlands of Nebraska" would be a seeming oxymoron.

It has been estimated (Dahl, 1990) that, at the time Nebraska was admitted to statehood in 1867, there were about 2,910,500 acres (4,500 square miles) of wetlands present, representing about six percent of the state's total area. Since then, Nebraska has lost about 35 percent of these, leaving 1,905,000 acres. This estimated remaining wetland acreage (about 3.9 percent of the state's area) is greater than estimates for South Dakota, Wyoming, Colorado, Kansas, Missouri, or Iowa (Dahl, 1990). Thus, Nebraska has a larger area of wetlands than any of its immediately surrounding states, and probably has a greater diversity of wetland types than do any of the other Great Plains states.

Wetlands are among the most productive of all North American ecosystems, supporting half of the U.S. species of fish, a third of its birds, almost a quarter of its plants, and a sixth of its mammals. Of Nebraska's total biota, it has been estimated that 50 percent of the state's plants are associated to some degree with wetlands, as well as 100 percent of its amphibians, 38 percent of its reptiles, 50 percent of its birds, and 36 percent of its mammals (LaGrange, 2005). Wetlands are also the primary habitats of many of America's nationally threatened and endangered species; those in Nebraska include the whooping crane, pallid surgeon, piping plover and interior least tern. Some of Nebraska's additional at-risk species that depend on wetlands include the river otter, trumpeter swan, bald eagle and king rail. The list of wetland at-risk species in Nebraska also includes 11 fish, two salamanders, two toads, and one turtle. Out of 600 species identified as at-risk in Nebraska (Panella, 2010), at last 40 might be regarded as aquatic or wetland-dependent. These include nine at-risk mussels and six aquatic, wet meadow or floodplain plants (Panella, 2010).

In 1982 the National Wetland Inventory was begun in Nebraska, following an estimated 87 percent nationwide loss in wetland acreage between 1955 and 1975, primarily as a result of unwise agricultural drainage practices (Elliott, 1991). Wetland mapping was based on the standard U.S. Geological Survey 7.5-minute quadrangle system, and the resulting maps are commercially available at a scale of 1:24,000 (about 2.5 inches per mile) from 1-800-USA-MAPS. They are also available from the University of Nebraska's Maps and More store at the Conservation and Survey Division, 619 Harden Hall, 3300 Holdrege St., Lincoln 68583(402/472-7523). These locality-named maps are identified by using the same names as those used in the U.S. Geological Survey's 7.5-minute quadrangle maps.

Wetland Definitions

The definition of what constitutes a wetland in general varies somewhat, but in 1987 the U.S. Army Corps of Engineers defined a wetland as having three specific criteria relative to its vegetation, soils and hydrology. A wetland's vegetation consists of hydric (water-dependent) plants adapted to growing in inundated or saturated conditions, its soils are of a type developed under inundated or saturated conditions that limit oxygen availability, and water-saturated or inundated conditions exist at some time during the growing season.

A generally accepted definition is that of Cowardin et al. (1979). Wetlands are communities (1) dominated by hydric macrophytes,(2) have hydric soils, and (3) experience periodic or permanent flooding at mean depths of more than two meters, or soil that is saturated to the surface at some time during the growing season. Open-water communities lacking hydric macrophytes also qualify as wetlands if they (1) are larger than eight hectares (20 acres), lack wave-formed or bedrock shoreline features, and water depth at the deepest part of the basin is less than two meters at low water.

A more generalized and internationally adopted definition was proposed during a 1971 convention in Iran, the Ramsar Convention on Wetlands of International Importance, Especially as Waterfowl Habitat. It defined wetlands in part as being areas of moor, fen, peatland or water, in which the depth of water does not exceed six meters (19 feet).

Lakes and Reservoirs

True lakes and reservoirs are not wetlands, but need to be discussed. All of Nebraska's largest and deepest water areas consist of reservoirs, which comprise most of the estimated 320 square miles of permanent standing water now present in the state, or about 0.4 percent of the state's overall geographic area.

Water bodies in Nebraska that are deeper than two meters (6.6 feet) and thus qualify as being called lakes are mostly reservoirs. The deepest natural lake in the Sandhills, if not the entire state, is Cottonwood Lake (Cherry County) which is about six meters (20 feet) deep. Other definitions of lakes have been based on their total surface area, such as water bodies that are larger than five to 12 acres (varying with the authority). Many of our natural water bodies in the Sandhills are thus large enough to be called lakes. The largest Sandhills lake is Big Alkali Lake (Cherry County), which at 290 hectares (720 acres) is perhaps the largest natural lake in the state. Although reservoirs are excluded from consideration as wetlands, many reservoirs have peripheral marsh-like features, and some large marshes have lake-like characteristics, making hard and fast distinctions among reservoirs, lakes and marshes impossible.

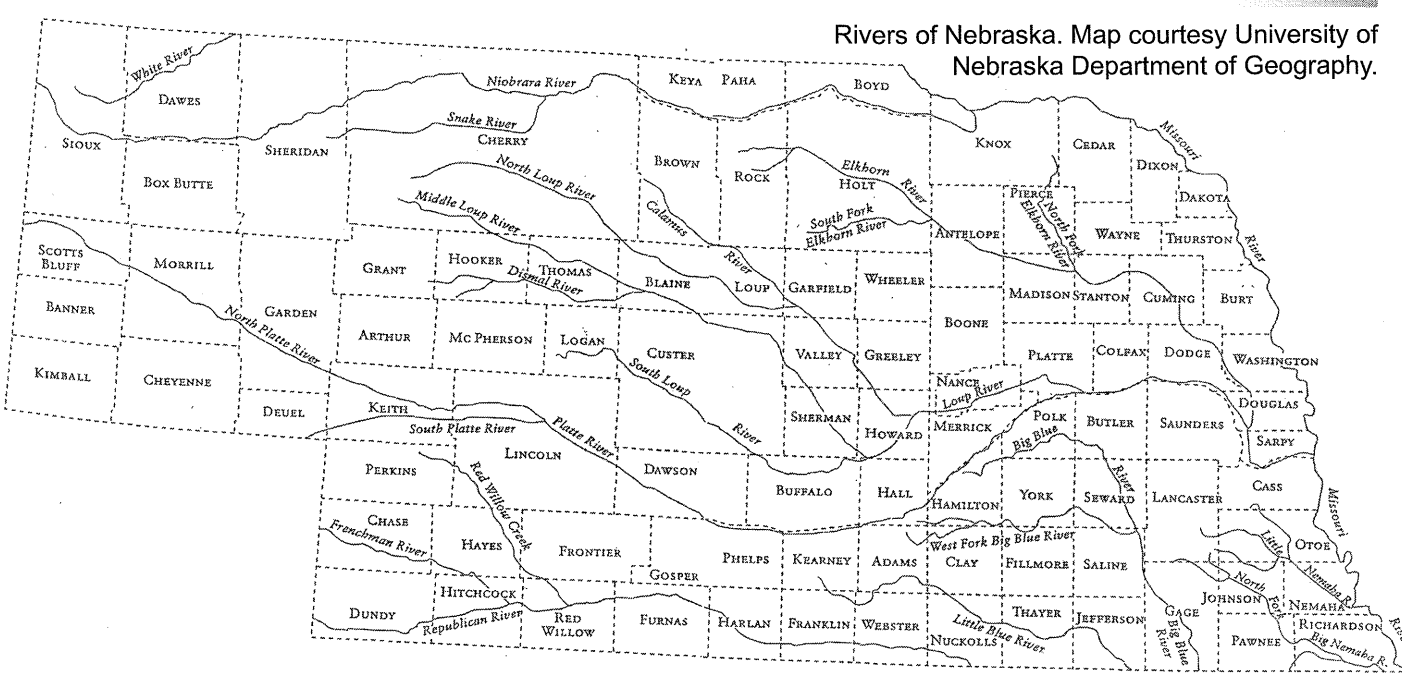
Rivers

Other than from reservoirs and lakes, most Nebraskans' contacts with surface water come from rivers, smaller streams, and canals which collectively represent over 23,600 miles of riverine interface between land and water (Zuerline, 1983)**(Map 1; Table 1).**

Rivers are also not considered wetlands, but their transitional relationships to land have important wetland components, such as their floodplains, backwaters, and oxbows. Their banks, floodplains and backwaters have served as migration routes for early east-west immigrants as well as modern travelers, offered cherished fishing and hunting grounds for children and adults, and have provided wildlife habitats for a significant percentage of our state's wildlife and plant diversity.

Nearly all of our cities have developed in association with rivers, which have provided water supplies for human consumption and agriculture, provided power for mills or electricity generation, and

Map 1

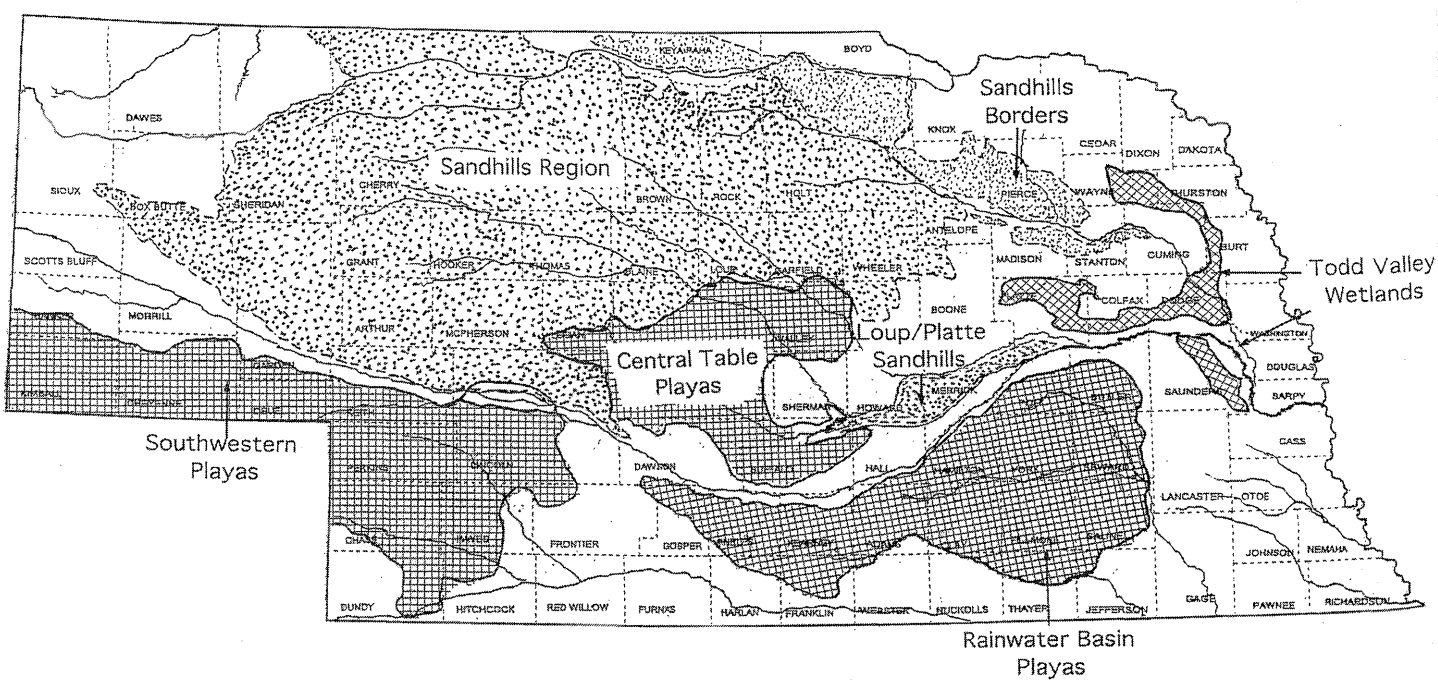


Rivers of Nebraska. Map courtesy University of Nebraska Department of Geography.

sources of water for industrial needs, such as heating or cooling. The land-water interface is a dynamic and complex one, providing the potential advantages of both land dwelling and aquatic living, plus some of the disadvantages of each, such as dangers of periodic flooding and droughts. Nearly half of Nebraska's human population now lives in counties bordering the Missouri River. Because of all of these and other valuable attributes of the Missouri and other Nebraska rivers, their significant values as wetland habitats have often been forgotten.

Many of our smaller rivers are called creeks, such as Lancaster County's Salt Creek, or the notably long Lodgepole Creek, stretching over 200 miles in western Nebraska and eastern Wyoming. There are no hard ecological distinctions among rivers and creeks other than their relative sizes; both are stream-based ecosystems. The continuous movements of water in streams can greatly influence the distribution, abundance and kinds of plants and animals that can survive within it. Moving water, for example, tends to dislodge and remove rooted or especially floating plants downstream. It also displaces unattached animals, unless they can exert the energy needed to remain in place against the current. Currents may bring oxygen, food or nutrients to a animal, but may also carry them away, just as a species' eggs, sperm or offspring may also be swept away.

Many important wetland regions in Nebraska are associated with the state's larger rivers, the Missouri, Platte and Niobrara, and to a lesser extent with the North Platte, and an extensive complex of smaller spring-fed Sandhills rivers **(Map 2)**.



Map 2. Major wetland regions of Nebraska. Map by author, adapted from LaGrange (2005).

Table 1

A Comparison of Nebraska's 21 Major Rivers*

River	Drainage Area (sq. mi.)	Nebraska Stream Miles	Public Access Areas**	Annual Discharge***
Blue (Big)	4,558	468	2; 1	558.6
Blue (Little)	2,650	195	-	267.3
Calamus	1,060	88	-	217.4
Cedar	1,220	87	-	173.9
Dismal	2,040	134	-	233.3
Elkhorn	6,900	276	6; 145	814.3
Frenchman	2,770	107	2; 1,718	78.2
Loup	15,200	162	7; 385	-
Middle Loup	8,090	204	1; 109	866.5
North Loup	4,290	209	-	701.3
South Loup	2,350	160	1; 30	176.1
Missouri	414,900	385	50+: 4,000+	28,450
Nemaha (Big)	1,340	140	1; 3	421.7
Nemaha (Little) 793	136	-	202.1	
Niobrara	12,600	486	5; 1,603	1,106
Platte	85,000	305	24; 1,117	4,098
North Platte	–	164	5; 37,590	–
South Platte	–	84	2; 40	–
Republican	22,400	285	5; 18,574	433.3
Snake	660	117	1; 2,906	108.7
White	2,130	127	-	14.6

* Hyphens indicate no available data. Information from Nebraskland 61(1):142–143 (1983).
** Number of state-owned properties, followed by total water acres. Information from Nebraskland 61(1):144–145 (1983). The Missouri River sites include Corps of Engineers reclamation sites. Additional areas have since been acquired, or site acreages may have been increased.
*** Average annual river discharge (1,000 acre/feet.)

River floodplains in Nebraska are typically cloaked with fairly narrow belts of woody vegetation, often called gallery or riverine forests. Those along the Missouri River are the tallest and most floristically diverse forests in the state, and are often dominated by cottonwood trees and other tree species having fairly high water tolerances or requirements. Smaller streams and those in arid past of the state are more likely to have brushy borders that are dominated by brushy willows, dogwoods, and other thicket-producing species.

Standing-water Habitats

Compared with Nebraska's often muddy rivers, our lakes and marshes usually have clearer water, as small, suspended materials tend to settle out. This water clarity means that more phytoplankton and other green plants can survive to deeper depths in the water, enhancing oxygen supplies at greater depths. However, standing waters also have less dynamic water-air interactions than flowing waters, and may have lower oxygen levels unless aquatic plants are abundant. As suspended solids settle on the bottom, producing mud-bottom substrates are produced that might help support the roots of plants, but muddy bottoms also may bury invertebrate larvae or eggs.

Of all the standing-water wetlands in Nebraska by far the most numerous are the Nebraska Sandhills

wetlands, An estimated 2,000 square miles of wetlands exist in the Nebraska Sandhills, which vary from and permanent lake-sized marshes through vegetation-lined marshes to permanent or seasonally wet meadows. These wetlands overlay the top of the vast Ogallala (High Plains) aquifer (Map 2). Over most of the Sandhills region the thickness of this aquifer or "groundwater reservoir" is more than 500 feet (Bleed and Flowerday, 1989). The Nebraska Sandhills encompass the thickest part of this massive Great Plains aquifer, which is believed to be the second largest groundwater reservoir of fresh water anywhere in the world.

The state's most strongly alkaline wetlands are found along the westernmost edges of the Sandhills in southern Sheridan and northern Garden counties, where annual precipitation is low and summer evaporation rates are relatively high. An estimated 2,500 closed-basin wetlands occur here, often with high alkalinity. Although no fish species are indigenous to that region, about a dozen fish species exist in the freshwater lakes and streams farther east in the Sandhills (McCarraher, 1977; Novacek, 1989).

There are also almost innumerable numbers of variably temporary and shallow wetlands in Nebraska. Most are precipitation-dependent, including very temporary ponds and other only slightly more permanent wetlands. Many of these were originally formed when strong post-Pleistocene winds scoured out depressions in loess- or clay- mantled landscapes (Starks, 1984, Krueger, 1986). These so-called "playa" wetlands are common in the central and southern Great Plains, from central and western Nebraska south to Texas (Bolen, Smith, and Schramm,1989).

Nebraska's playa wetlands (Map 2) are most evident in the so-called "Rainwater Basin" south of the Platte River, where ephemeral wetlands developed in silt- or clay-based soils having fairly impermeable clay bottoms that impede or prevent drainage. The results are temporarily flooded lowlands that rely on winter snowfall and early spring rains for their maintenance. Accumulated salts are sometimes present in the water if they are prevented from being removed through runoff, and have not been leached down to substrate levels where they are no longer of biological significance.

Because of such variables, playa wetlands may range from freshwater to highly alkaline in the chemical composition of their waters, which is often a more significant biological variable than is the total volume or relative permanence of water that may be present.

Marshy wetlands having permanent or temporary surface water often grade into permanent or seasonal wet meadows. Meadows in turn are transitional to dryland habitats. Likewise river and creek edges have transitional communities that grade into upland habitats.

A Classification of Nebraska's Wetlands

In **Table 2** a summary of major wetland community types that occur in Nebraska is provided, based mostly on classifications of Iowa wetlands by Thompson et al. (1992) and Runkel & Roosa (1999). They are briefly summarized below.

I. Riverine Wetlands

The major rivers of the state with important wetlands are the Missouri, Niobrara and Platte. Additionally there are several other important rivers, especially the Republican, and some spring-fed Sandhills rivers such as the Elkhorn, Calamus and Loup, that are also significant to the state. All of these smaller streams are rather similar to the larger ones except that the spring-fed Sandhills streams tend to have very stable seasonal flow rates and sandy rather than muddy bottoms. Some of the state's larger rivers, such as the Niobrara, are also significantly fed by artesian-fed tributaries, especially in their more eastern reaches. As a result these rivers are more uniform in their seasonal flow rates. The Platte is also largely fed in its lower reaches by spring-fed tributaries, but its central reaches have lost over 70 percent of their historic annual flows to agricultural activities. Nearly all of other Nebraska's rivers have also been impacted to some degree by water extractions, diversions, and dam construction.

Nebraska's riverine systems are now under the

shared management of various federal agencies. such as the U.S. Army Corps of Engineers(8901 S. 154TH ST., Omaha, NE 68138: Ph.402/896,0723), and the U.S. Fish & Wildlife Service (203 W. 2nd St., Federal Bldg., Grand Island NE 68801: Ph. 308/382-6468). State- level management mostly vested in Nebraska's Department of Environmental Quality (P.O. BOX 98922, Lincoln, NE: Ph. 402/471-2875), and in 23 Natural Resources Districts (NRDs), which are defined geographically on the basis of Nebraska's river basins. The functional significance of these entities is summarized in Chapter 6. Additional information on the roles of NRDs can be found at the agency's state office (402/471-7670) or its website: www.nrdnet.org. Each of Nebraska's 23 individual NRDs also has a separate office and website.

1. Riparian Floodplains

Along all riverine areas, transitional floodplain communities connecting the stream to upland habitats exist. Here soil inundation may periodically occur, or the roots of terrestrial plants may be able to reach a fairly constant supply of water. However, floodplain plants may also be subjected to destruction by being swept away as a result of shoreline erosion. Alternatively, the plants may be buried by sediment deposition during flooding periods, or through the stream's normal channel-shifting behavior. Floodplains tend to produce highly fertile soils, from nutrients and sediments that have been carried in from farther upstream.

Floodplain wetlands are true edge communities, providing organisms with the dual advantage of both aquatic and terrestrial habitats. Terrestrial animals thus easy access to the resources provided by water, but aquatic species are also provided opportunities for terrestrial nesting, burrowing, access to land-based resources, and the like. The linear "gallery" forests that often develop along them may also provide convenient corridors for long-distance movements of terrestrial animals.

II. Standing-water (Lacustrine and Palustrine) Wetlands

There have been various suggestions for classifying standing-water wetlands, which like most biological communities represent a continuum of ecosystems. Two useful and fairly simple classifications includes Shaw and Fredine's (1956), which was designed to apply throughout the United States, and Stewart and Kantrud's (1971), the latter especially applicable to wetlands in the glaciated northern plains. Their comparative classifications, at least those including Nebraska's wetlands, are as follows:

Shaw & Fredine's Wetland Types

1. Seasonally flooded basins or flats
2. Inland fresh meadows
3. Inland shallow freshwater
4. Inland deep marshes
5. Inland open freshwater lakes
6. Inland saline marshes

Stewart & Kantrud's Wetland Classes

I. Ephemeral ponds
II. Temporary ponds
III. Seasonal ponds & lakes
IV. Semipermanent ponds and lakes
V. Permanent ponds & lakes
VI. Alkali ponds and lakes

Standing-water wetlands in Nebraska may be owned by the federal government, state or private entities, and thus might be under the control and management of varied groups, such as the U. S. Fish & Wildlife Service, the Natural Resources Conservation Service (formerly the Soil Conservation Service), and the Nebraska Game & Parks Commission. Many ecologically important wetlands are also owned by environmental groups such as The Nature Conservancy, The Crane Trust and the National Audubon Society. Altogether, about 50,000 acres of wetlands are now variously protected by organizations in the state such as those just mentioned, or only about three percent of the estimated total wetland acreage (LaGrange, 2005).

Regardless of ownership, America's wetlands are protected by the federal Clean Water Act, and persons receiving federal farm benefits from the Farm Bill must abide by its Swamp buster provisions (that prevent wetland destruction)

to maintain their eligibility benefits. There are many local offices of the Natural Resources Conservation Service (NRCS) that can provide local information on wetland protection. The address of the Department of Natural Resources is 301 Centennial Mall, Lincoln NE 68509 (402/471-2363).

1. Lake-like (Lacustrine) Wetlands

Few if any natural lakes occur in Nebraska outside the limits of the Sandhills. Lakes typically are large enough for wave action to be strong enough that barren, wave-washed shorelines occur along at least some parts of the wetland's perimeter. McCarraher (1977) collected water data from 1,640 Sandhills "lakes" measuring larger than four hectares (9.9 acres) in area. Very few of these Sandhills wetlands are deep enough to qualify on a depth-defined basis as lakes. Most of Nebraska's Sandhills lakes are thus better described as lake-sized marshes. Such large, shallow marshes have been described as "lacustrine lagoon marshes" (Robinson, Gurney, and Goldsborough, 2000), and in the Rainwater Basin region the larger wetlands are similarly called lagoons.

2. Emergent Vegetation Marshes

Freshwater marshes represent more than 90 percent of all U.S. wetland areas. Unlike larger and deeper lakes, marshes are typically wholly surrounded by shoreline vegetation, the latter often consisting of emergent cattails, bulrushes, reeds, or rushes. They are too shallow for seasonal temperature stratification to develop, and their bottoms are sufficiently close to the surface that sunlight can penetrate and allow for rooted plants to survive even in the deepest locations. In deeper areas these plants may include only submerged-leaf aquatics, such as various pondweeds, but in shallower areas floating-leaf pondweeds and water lilies are typical.

Sandhills marshes are biologically the most diverse and productive of all Nebraska's wetlands. They provide breeding habitat for at least 53 wetland-adapted bird species, or 25 percent of the state's roughly 210 nesting species and, including migrants, attract about 80 aquatic bird species. They also support many semi-aquatic mammals such as muskrats, minks and raccoons, and a substantial diversity of amphibians, turtles and snakes.

3. Playa Wetlands

Playa wetlands are those transitory wetlands that develop in depressions as a result of snowmelt or excessive rainfall, forming wet meadows, swales or shallow marshes that may persist for weeks, months, or even an entire growing season. The "Rainwater Basin" of south-central and southeastern Nebraska historically supported thousands of these wetlands (Map 2). That area consists of about 4,250 square miles (11,000 square kilometers), spread out over parts of 15 counties, from Dawson and Gosper counties in the west to Butler, Seward and Saline counties in the east. The region once held an estimated 4,000 wetlands covering some 211,000 acres (about 330 square miles). The soils of that region are mostly clay-based, which retards subsurface drainage. As a result, water seasonally accumulates, usually flooding the previous-year's terrestrial plant life and making it easily available to wading, swimming and diving birds. For such reasons these wetlands are extremely important staging areas for migratory waterfowl during spring, when they are at their fullest. By fall, when the birds return, the wetlands are usually dry, but then offer thick, weedy habitat for many terrestrial birds and mammals.

An estimated 90 percent the Rainwater Basin wetlands were ditched and drained during the past century, but most of the remainder are now under state and federal management. Of these, about 22,000 acres of wetlands and grasslands in 59 parcels are currently under federal management as Waterfowl Production Areas, and over 12,000 wetland acres are under state control, as Wildlife Management Areas.

In 2011 the U.S. Fish and Wildlife Service announced that it hoped to increase its acquisition goal by 14,000 additional acres, through a combination of purchase (9,000 acres) and conservation easements (5,000 acres). Under these programs many of the once-drained

wetlands have been converted back to provide important seasonal wetland habitat. Because of the current relative scarcity of these wetlands, massive overcrowding of migrant spring waterbirds such as geese often occurs, producing opportunities for diseases such as botulism and fowl cholera to spread among the stressed birds.

4. Alkaline and Saline Wetlands

Alkaline wetlands are a relatively rare wetland type in Nebraska, and primarily occur in the western Sandhills and in the North Platte Valley (Map 2). In all these areas salt concentrations in the soil and wetland substrates are so high as to restrict the kinds of plants and animals that can survive there, but do allow for a few saline-adapted species to thrive.

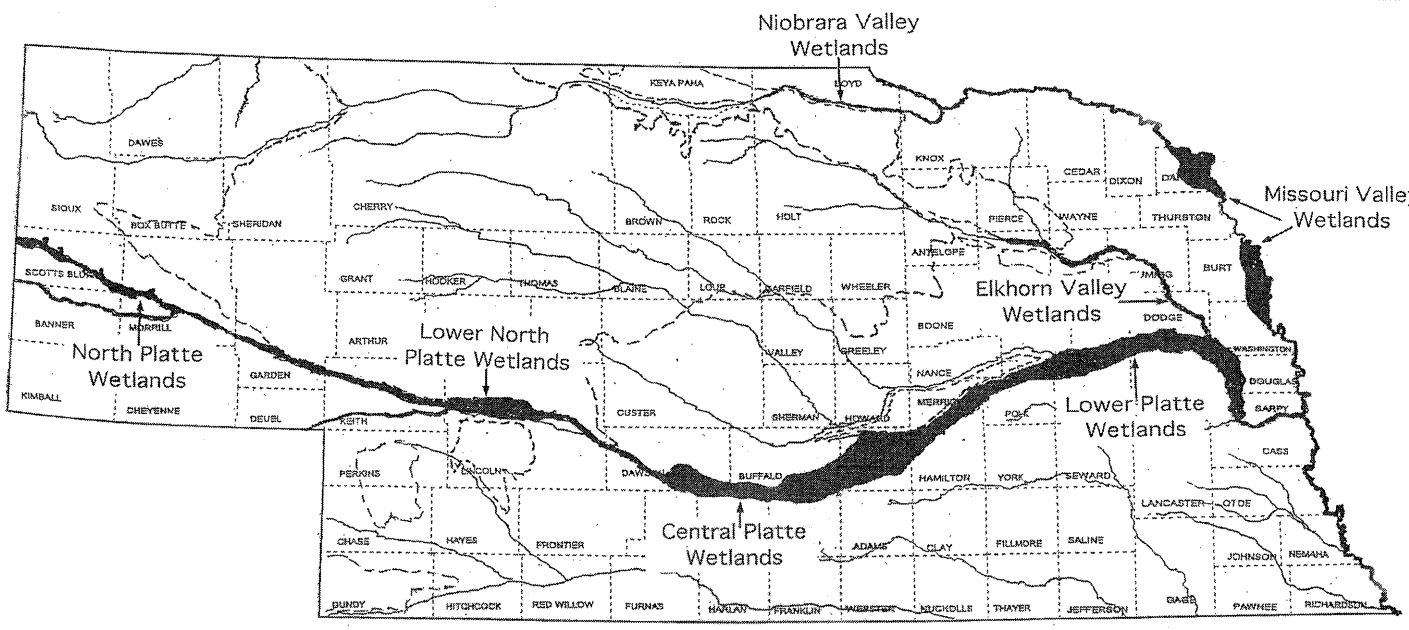
Relative to their increasing degrees of alkalinity, wetlands may be described as slightly alkaline to strongly alkaline (hyperalkaline). In descending frequency, sodium, phosphorus, magnesium and calcium are the most common cations in the Nebraska Sandhills wetlands, and bicarbonates, sulfates and chlorides are the typical anions. Nebraska's alkaline wetlands are often of the sodium bicarbonate type, with pH values ranging from 7.8–10.8(McCarraher, 1977).

A small region of alkaline wetlands relatively rich in dissolved sodium salts occurs in southeastern Nebraska's Lancaster County, within the drainage of the Salt Creek and its tributaries (Map 2). Salt Creek flows in a general northern direction from its origins in southeastern Lancaster County, passes through Lincoln, and flows on to the northeast, where Little Salt Creek and Rock Creek contribute their own shares of saline content. The water from all of these sources flows through a layer of porous Dakota sandstone lying below much more recent loess deposits. They acquire their salt content from passing over even deeper layers of shales that were deposited during Cretaceous times, when nearly all of Nebraska was still covered by a salty inland sea. Saline wetlands may vary in dissolved salt content from moderately saline (300–1,000 ppm), saline (1,000-10,000 ppm), very saline (10,000–30,000 ppm) to extremely saline (over 30,000 ppm)(Rawson & Moore, 1944).

5. Wet Meadows and Fens

Along many low river floodplains, such as long the lower and central Platte River, and in the Nebraska Sandhills, subirrigated meadows occur. They often outwardly resembling tallgrass prairies, but have a higher incidence of sedges and rushes, and a lower incidence of forbs. Wet

Map 3



Map of riverine wetlands of Nebraska. Dashed line north of Platte River indicates limits of the Nebraska Sandhills; dashed lines south of the Platte show sandsage transition zone of Sandhills and short-grass prairie. Map by author, from Johnsgard (1995).

meadows in Nebraska may be distinguished from marshes in not having seasonally to permanently flooded water regimes, and organic soils greater than 30 centimeters (12 inches) in depth. Fens are further separated from wet meadows by having saturated, groundwater-fed wetlands with organic soils over 30 centimeters deep. The deepest accumulation of organic deposit from a Sandhills fen is 6.7 meters (over 21 feet) at the Jumbo Valley fen, in Cherry County (Steinauer, Rolfsmeier and Hardy, 1996).

Bogs also accumulate peat and are thus related ecologically to fens. They are most common in cooler and recently glaciated regions of the northern Great Plains, especially Minnesota. Bogs also occur rarely in Iowa, but appear to be lacking in Nebraska. Bogs and fens might both be regarded as glacial relicts, for they sometimes contain plants that are much more typical of wetlands well to the north of Nebraska, and that became marooned here with the retreat of the last glacier. Nebraska's fens are largely limited to the Sandhills, and mainly occur in Cherry County, especially along stream valleys and at the upper ends of Sandhills lakes and marshes (Steinauer, Rolfsmeier and Hardy, 1996).

A few small fens also occur in sandstone canyons associated with the Missouri River (Burt and Thurston counties) and along the lower Little Blue River (Jefferson County).

In the Sandhills fens generally are found along the edges of marshes or lakes, and at the headwaters of Sandhills streams. The peat that is associated with them is sometimes quite thick.. The seepage of groundwater to levels above the soil surface results in reduced air circulation, inhibits bacteria activity, and prevents the breakdown of organic matter, which builds up as peat.

Unlike the bogs of Minnesota and Canada, the water is not especially acidic' those studied in Cherry County had pH values ranging from 6.0–6.9. Calcium ion levels in these fens ranged from 8.0 to 115.2 mg/l, while magnesium ions ranged from 4.9–13.7 mg/l (Steinauer, Rolfsmeier and Hardy, 1996). Rather than being dominated by sphagnum and other mosses, the relatively high mineral nutrient levels often allow for the growth of a wide variety of grasses and forbs. Additionally, the cool groundwater allows plants typical of more northern climates to survive. Thus, at least twelve rare Nebraska plants have been found surviving on Nebraska fens that otherwise are typical of Canada and the northern states, and 21 species that are considered rare in Nebraska. Most of the Sandhills fens have long since been drained and converted to hay meadows, but a few protected examples still survive, such as a fen at Dewey Lake, in Valentine National Wildlife Refuge.

6. Seeps

Especially in the Sandhills, small springs and seeps emerge from the base of tall dunes that at some time in the past may have blocked a natural waterway. This blockage causes the drainage to impound on the upstream side of the dune, forming a marsh or shallow lake, and to reappear on the downstream side as an artesian stream. Examples include Birdwood Creek and Clear Creek along the southern edges of the Sandhills. Both of these creeks eventually flow into the Platte River. Other spring-fed streams occur in the northern Sandhills, where creeks emerge at the heads of springbranch canyons, and flow into the Niobrara River. Such streams tend to be unusually clear, and often support cold-adapted fish, including some rare glacial relict species.

7. Ephemeral Ponds

Ephemeral ponds are relatively small and temporary wetlands, sometimes only a few inches to a foot or less deep, and are often less than about 100 feet (30 meters) wide. "Vernal" ponds are recharged each spring, from snowmelt or spring rains, and for a time may attract frogs and toads. They may also host an abundance of invertebrates such as fairy shrimp or tadpole shrimp, whose eggs have remained dormant since the previous wetland cycle. Within weeks, or at most a month or two, the water is gone and an array of annual plants soon carpets the bare ground. These ephemeral ponds are most common in eastern Nebraska, especially in shaded woodlands, where evaporation rates are sufficiently reduced as to let their water persist long enough for aquatic insects such as mosquitoes to thrive,

and for chorus frogs to complete their life cycles.

8. Oxbows

Oxbows are floodplain wetlands that originated as cut-off sections of a river to become still-water habitats. Oxbows are often U-shaped, the configuration sometimes resembling an oxen yoke. Oxbows are best developed in areas of fairly flat and wide floodplain topography, such as along the Elkhorn River and unchanneled portions of the Missouri River. Examples include Carter Lake in Omaha, Lake Manawa in Council Bluffs, and DeSoto Lake in DeSoto National Wildlife Refuge. Some slow-flowing Nebraska rivers such as the Elkhorn are notable for their many oxbows.

9. River Backwaters and Reservoir Inflows

River backwaters are periodically flooded areas of the floodplain wetlands that are thereby isolated, and reservoir inflow areas are those locations where a river is becoming impounded, progressively stopping its current. Because of these conditions both wetland types have lost the flowing-water characteristics of rivers, and tend develop variably marsh-like or swamp-like attributes.

In the central Platte Valley many now extinct channels of the Platte River are occasionally flooded during early spring, producing temporary wetlands that may isolate fish and other river wildlife as the waters recede. One of the best Nebraska examples of reservoir inflow wetlands is the marshy Clear Creek Wildlife Management Area at the western end of Lake McConaughy. The Bazile Creek marshes at the western end of Lewis and Clark Lake, and the contiguous marshes of South Dakota's Lewis and Clark Lake State Recreation Area, are also representative.

10. Miscellaneous Impoundments

Miscellaneous impoundments include relatively small wetlands produced by human excavations, such as farm ponds, often with varying degrees of similarity to naturally occurring wetlands. Similar "dugouts" (also called borrow-pits) and farm ponds rely on local run-off and precipitation for maintaining water levels.

Gravel and sand excavation activities, especially in the Platte Valley, have resulted in the formation of wetlands that are sometime quite large and deep, producing lake-like wetlands attractive to diving birds and to species such as least terns and piping plovers that use the barren sandy shorelines for nesting. Many sand and gravel pits were dug during the construction of Interstate 80 in the central Platte Valley, in order to produce the chain of Interstate lakes that still exist, and are at least in part maintained by the high local water table associated with the Platte River.

Nebraska's Wetland Plant Communities

The most recent and comprehensive attempt to classify and describe all of Nebraska's natural plant communities is that of Rolfsmeier and Steinauer (2010). With some sequential reorganization, their classification of the state's wetland community types may be summarized and outlined as follows:

Riparian Forests

1. Eastern Riparian Forest

Riparian Woodlands

1. Cottonwood Riparian Woodland
2. Cottonwood-Peachleaf Willow Riparian Woodland
3. Eastern Cottonwood-Dogwood Riparian Woodland
4. Cottonwood-Diamond Willow Riparian Woodland
5. Peachleaf Willow Riparian Woodland

Riparian Shrublands

1. Sandbar Willow Riparian Shrubland
2. Dogwood-False Indigobush Riparian Shrubland

Herbaceous Wetlands

1. Wet Prairies and Wet Meadows
   - Eastern Cordgrass Wet Prairie
   - Northern Cordgrass Wet Prairie
   - Eastern Sedge Wet Meadow
   - Sandhills Wet Meadow
   - Western Sedge Wet Meadow
2. Fens
   - Prairie Fen
   - Sandhills Fen
3. Alkaline/Saline Wetlands

Eastern Saline Meadow
Western Alkaline Meadow
Western Subirrigated Alkaline Meadow
Western Alkaline Marsh
Saline/Alkaline Aquatic Wetland

4. Freshwater Marshes
Eastern Bulrush Deep Marsh
Cattail Shallow Marsh
Sandhills Hardstem Bulrush Marsh
Reed Marsh

5. Freshwater Aquatic Wetlands
Eastern Pondweed Aquatic Wetland
American Lotus Aquatic Wetland
Northern Pondweed Aquatic Wetland
Water-lily Aquatic Wetland

6. Freshwater Seeps
Marsh-type Seep
Spring-type Seep

7. Sparsely Vegetated Wetlands
Perennial Sandbar
Sandbar/Mudflat

8. Ephemeral Playas and Vernal Pools
Playa Wetland
Spikerush Vernal Pool

The Present and Future of Nebraska's Wetlands

As a way of understanding the relative current sizes and degree of wetland losses in recent years, a tabular summary (Table 2) is useful, based on studies of LaGrange (2005) and LaGrange et al. (2005). Although now more than 15 years old, this survey is still the best available overview of the geographic extent of Nebraska's wetland heritage.

The values of wetlands are many. They help to reduce the frequency and intensity of flooding, by storing excess water. Thy provide a means of ground water recharge, and serve as a "sink" for pollutants as well as for excess nitrates from agricultural fertilizers. They also are important habitats for more than 125 species of Nebraska's birds, including many of great economic importance, such as ducks and geese.

Recognizing these values. the national rate of wetland losses has been reduced in recent decades, thanks largely to section 404 of the Clean Water Act of 1972. This act requires that all activities (digging, draining, filling, etc.) having an impact on wetlands must be approved by the U.S. Corps of Engineers, using guidelines set forth by the Environmental Protection Agency. The Clean Water Act has since been enhanced by later amendments.

In 1985 the Wetland Reserve Program was established under the Food Security Act, and renewed with the 1990 and later Farm Bills. The Food Security Act and a later (2008) Farm Bill has a "swamp buster" provision that helps prevent the drainage of wetlands and their conversion to agricultural purposes.

In the spring of 2011 the House of Representatives nearly stripped the Wetlands Reserve and Conservation Stewardship Program and the North American Wetlands Conservation Act from their proposed budgets, but later settled instead for deep funding cuts. In 2011 the Land and Water Conservation Fund was reduced by more than one third from the 2010 levels, and more than $1 billion was stripped from the Wetlands Reserve, Wildlife Habitat Incentives and Environmental Quality Incentives programs.

The Wetlands Reserve Program is administered through the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service. Under this program wetlands may be purchased or easements established on a cost-shared basis. The NRCS helps oversee the prevention of wetland conversions, and the Department of Interior is in charge of the Emergency Wetland Reserve Program, which obtains easements on or purchases flood—prone lands. Wetlands have also been acquired through in-state funding by the Nebraska Environmental Trust and the Nebraska Land Trust. In Nebraska the state's Department of Environmental Quality also helps to prevent wetland destruction through the Nebraska Surface Quality Standards, Title 117.

Important wetlands in the central Platte Valley are currently being preserved and restored through the Platte River Recovery Implementation Plan a multi-state (Colorado, Wyoming and Nebraska) and federal cooperstive program designed to protect the wetland habits of four federally threatened or endangered species (Johns-

Table 2

*Nebraska's Major Wetland Types**

Non-riparian Wetlands

Lake-like Marshes: Wetlands that are larger and deeper than emergent vegetation marshes. They often have areas of open water supporting submerged or floating hydrophytes, and are ecologically intermediate between emergent vegetation marshes and typical lakes, grading into both.

Emergent Vegetation Marshes: Freshwater wetlands that are dominated by shoreline and emergent hydrophytes.

Wet Meadows: Herbaceous wetlands typically sedge-rich and irrigated by a subsurface water table, or located along the edges of marshes or streams.

Fens: Herbaceous and peat-forming wetlands dependent on a permanent source of water (often springs or seeps) in addition to atmospheric precipitation, and having a minerotrophic or mesotrophic nutrient status (Thompson et al., 1992). Bogs (not known to be present in Nebraska) are cold-climate peaty wetlands that are more nutrient-poor and variably more acidic.

Seeps and springs: Herbaceous wetlands that originate from subsurface aquifers reaching the land surface, often producing wet meadow or fen communities.

Playa Wetlands: Herbaceous wetlands that form in depressions periodically filled with seasonal precipitation, and often become totally dry at other times. Nebraska's playa wetlands were mostly formed where wind-scouring has excavated loess or clay soils, and the presence of clay subsoil prevents rapid drainage.

Alkaline Wetlands: Wetlands with pH characteristics greater than 7.4. They often occur in Nebraska in regions of high substrate salinity and high rates of evaporation, and have variably reduced plant and animal diversity. Nebraska's most alkaline wetlands in the Sandhills region have dissolved solid contents as high as 448,000 ppm, and dissolved salt concentrations up to 44.0 percent (McCarraher, 1959). In Nebraska's more strongly alkaline wetlands the usual relative cationic concentrations in diminishing abundance are sodium, potassium, magnesium and calcium. The usual anionic components in slightly to moderately alkaline Nebraska wetlands are, in diminishing abundance, carbonates, bicarbonates, sulfates and chlorides (McCarraher, 1977). Saline wetlands are alkaline wetlands with concentrations of dissolved solutes, especially sodium salts, of at least 300 ppm.

Riparian Wetlands

Floodplain Forests: Tree-height (20-30 meters) vegetation, often of mixed hardwoods, growing on alluvial soils that have been deposited by floodwaters and vulnerable to periodic flooding.

Floodplain Woodlands: Mixed tree- and shrub-height vegetation, often of cottonwoods and willows, growing along the edges of streams.

Floodplain Shrublands: Shrub-height (2-4 meters) vegetation, often of willows, growing along the edges of streams.

Miscellaneous Wetlands

River Backwaters and Reservoir Inflow Areas: Wetlands that are transitional between flowing-water (lotic) and standing-water (lentic) habitats. River and reservoir fluctuations may also produce temporary or permanent oxbows or floodplain ponds.

Oxbows: Still-water wetlands that have been isolated from a river and are often variably marsh-like.

Floodplain Ponds and Vernal Pools: Usually ephemeral wetlands dependent on periodic riverine flooding (floodplain ponds) or seasonal precipitation (vernal pools). Vernal pools grade into playa wetlands, and floodplain ponds grade into oxbows.

Artificial wetlands: Human-constructed wetlands, such as sandpits, borrow-pits, drainage ditches and irrigation canals.

* Adapted in part from Thompson et al. (1992), Runkel and Roosa (1999), and Rolfsmeier and Steinhauer (2010).

gard, 2008). As of 2011, or about halfway into the initial 13-year funding period, about 80 percent of a proposed 10,000 acres of central Platte Valley wetlands have been preserved through purchase, conservation easements or other methods.

The multi-state Playas Lakes Joint Venture Program of the southern High Plains has also helped greatly to preserve wetlands in the playa region of south-central and southwestern Nebraska. The Joint Venture is a coalition of federal, state and private groups dedicated to conserving birds and bird habitats in the southern Great Plains, from Nebraska to Texas, where over 60,000 playa wetlands exist, as well as about 100 saline lakes.

All of these wetland types are both valuable and fragile, and will require biological expertise and financial support if they are to remain part of Nebraska's natural legacy. The futures of many of our plants and animals depend on the decisions that we make regarding them.

Chapter 2

The Missouri Valley Region

The Missouri River is Nebraska's largest river, and during early historic times was lined with vast wetlands and floodplain forests that we can scarcely imagine today. The most historically important of Nebraska's rivers, the Missouri has greatly shaped our history and effected our economy. At the time of Lewis and Clark's passage up the Missouri in 1804, the river section that now includes Nebraska was a total wilderness, with high populations of huge catfish (probably both blue and channel catfish) and many other fish. There were countless wetland birds such as piping plovers, least terns, American white pelicans, great blue herons and Canada geese, and then-economically important mammals such as beavers, bison and elk.

Lewis and Clark estimated the river length from the mouth of the Kansas River to the northernmost Nebraska-South Dakota boundary as 691 miles (Johnsgard, 2003), or nearly twice as long as it might have been if no bends had been present. When they passed through the area in 1804 that is now known as Decatur, they determined that at that point the river's course stretched 18 miles, while covering only 974 yards (0.55 mile) of north-south distance. Prior to river straightening activities, the Missouri's historic length was far greater but, through channelizing and straightening, 127 miles have been removed from the river's original channel. The Missouri's current length of 385 miles that now flows past Nebraska is about 75 percent of the that which was calculated by Lewis and Clark in 1804.

From the northeastern boundary of Nebraska at Sioux City to the Missouri–Mississippi confluence near St. Louis, the Missouri's floodplain now covers some 1.9 million acres. However, about 30 percent, including 100,000 acres of aquatic habitat, 65,000 acres of islands and sandbars, and 300,000 acres of riverine floodplain habitat, has been lost to channelization for navigation purposes, or has been converted to dry land (U. S. Fish and Wildlife Service, 1980). Nearly 20 percent of the collective wetland losses have occurred in Nebraska (Fowler, 2003). Here the total wetland losses perhaps have amounted to as much as nearly 114,000 acres of river and associated riparian floodplain habitats (Gene Zuerlein, pers. comm.).

Historically, the Missouri River flooded twice a year, the first occurring in April, when the northern Great Plains' snowfall melted, and again in June, when snowmelt from the Rocky Mountains of Montana and Wyoming finally reached the Plains. During the 1930's and 1940's the U. S. Corps of Engineers began channelizing the river to facilitate navigation. Between Ponca, Nebraska, and the mouth of the Missouri in Missouri, about 8,000 water-control structures such as wing dams were built, to keep the river within its banks and divert the flow toward the middle of the river. The resulting narrower and deeper channel also resulted in swifter flow rate. The river's character was transformed from a lazy stream about 5,000 to 10,000 feet wide at Sioux City moving at a rate of two miles per hour, to a 740-foot-wide channel flowing at six miles per hour. The channelized Missouri thus became a nearly straight and dangerously swift river that is only about 600 feet wide over most of its Nebraska length. These faster flows also resulted in a greater flow energy and increased erosive capabilities.

With these changes, there has been a progressive loss of its wetland backwaters, oxbows, sloughs, marshes, sandy islands, snags and pools (U. S. Fish and Wildlife Service, 1980). Channelizing of the Missouri not only destroyed most of the adjacent wetlands that once occurred along nearly all of its Nebraska length, but also eliminated the possibility of these wetlands capturing and storing periodic floodwaters along the river's wide floodplain.

Following Congress's passage of the Flood Control Act of 1944, the Corps of Engineers also started damming the river to control flooding, with the promise to end the threat of major Missouri River flooding for as long as 500 years. Through the 1960's hundreds of millions of dollars were spent on federally

funded programs to control Missouri River flooding, primarily by the construction of six mainstem dams between Montana and South Dakota, as well as dams on several of the river's major tributaries.

Contrary to the Corps' calculations, Missouri River flooding became less frequent but far more severe and destructive following dam completions, with serious to devastating floods occurring in Nebraska during 1952, 1967, 1984, 1990, 1993, and 2011. In May of 2011, with the melting of mountane snowpacks and following major rainfalls in the Dakotas, a record 10.5 million acre-feet of water flowed into the river above Sioux City, shattering the all-time previous record of 7.2 million acre-feet set in 1995. The result was a massive Nebraska flood disaster, with flood-stage water levels persisting in the Missouri Valley throughout the entire summer of 2011.

Mainstem flood-control reservoirs upstream from Nebraska have also altered seasonal flow patterns in such a way as to influence or disrupt terrestrial breeding and aquatic spawning cycles of great numbers of native species. Two riparian forest bird species that once occurred along the river, the Carolina parakeet and passenger pigeon, are now extinct, and other riparian forest birds such as the ruffed grouse and swallow-tailed kite were extirpated from Nebraska by the start of the 20th century. The pallid sturgeon and interior least tern are now nationally endangered, and the Great Plains population of the piping plover is nationally threatened. Introductions of non-native plant species such as common reed and reed canarygrass, and exotic fish such as carp, have produced further complications in the ecology and biodiversity of the Missouri and other Nebraska rivers.

Within Nebraska, the only section of the Missouri River still remotely resembling its historic condition is the approximately hundred-mile unchannelized downstream stretch from where the river enters Nebraska, at the South Dakota–Nebraska boundary in northeastern Boyd County, southeast to the vicinity of Ponca State Park. Since 1991 this stretch of river has been encompassed within and protected by the Missouri National Recreational River system. However, its annual and seasonal flows are still greatly affected by upstream dams, which often influence the breeding and spawning success of wetland-dependent birds and fishes.

For example, the cold waters released by these reservoirs alter the times at which aquatic insects reproduce, and the water release pattern, which is timed to result in high water levels in summer and low ones in winter. This flow regime often produces flooding of spring nests among island- and sandbar-nesting species, such as piping plovers and least terns. Native fish are also impacted; a 1994 study by the Nebraska Game and Parks Commission found a reduction of 78–98 percent in several chub and minnow species native to Nebraska's Missouri River. The clear waters found below large dams also favor those fish that hunt visually, rather than several increasingly rare to endangered species adapted to feeding in turbid waters, such as shovelnose and pallid sturgeons, paddlefish and several species of catfish (Fowler, 2003).

The collective effects of these river manipulation projects since the 1930's and 1940's thus destroyed a vast amount of riverine habitats. Countless miles of river length have ben lost though straightening and channeling activities, as well as untold amounts of destruction to wetland habitats.

In recent years efforts have been made to try to restore the river to counteract its degraded state, since the dams on it have failed to prevent occasional devastating floods. Some, such as Lewis and Clark Lake, have become so silted-in that much of their planned flood-control capacity has been lost. Additionally, the once-important barge traffic on the river has become negligible, and has been largely replaced by much faster rail and truck transport. Early efforts in the direction of river rehabilitation were formalized in the federal Water Resource Development Acts of 1986 and 1999, and subsequently in an 2007 update. A federally mandated Missouri River Ecosystem Recovery Program was initiated in 2008, and will continue until 2018.

Many of the specific activities resulting from these programs and affecting Nebraska wetlands have been with mitigation efforts by the Corps of Engineers in several Nebraska sites. These include Blackbird-Tieville-Decatur Bend (Burt and Thurston

counties), Tobacco Island (Cass County), Hamburg Bend (Otoe County), Langdon Bend (Nemaha County) and Kansas Bend (Nemaha County).

Governmental purchases of high-risk flood-prone lowlands, and alterations of the Missouri's present-day river pattern have caused it to more closely resemble historic conditions through the construction of channel by-passes (chutes) and other flow modifications. As a result, there has been an increase in variations in flow velocity and channel width, and a greatly increased diversity of riverine habitats. As of 2010, these project had restored 18,000 riverine acres, out of an estimated 48,000 acres previously lost to destructive bank stabilization and navigation activities undertaken by the U. S. Army Corps of Engineers.

Threatened and endangered species that have benefited from these mitigation efforts include the pallid sturgeon, least tern, and piping plover. The pallid sturgeon relies on large, muddy or sandy rivers for it survival and spawning, while the tern and plover primarily depend on sandy islands and bars for nesting, especially in relatively inaccessible mid-channel locations where they are better protected from most land-based egg and chick predators.

Some beneficial effects of new adaptive river management efforts have been shown with least tern and plover nesting success. High spring flows in the upper and middle Missouri the late 1990s followed by rapid declines rebuilt sandbars in unchannelized reaches of the river. The average number of tern and plover chicks from 1998 to 2001 correspondingly increased by more than 200 percent between South Dakota's Fort Randall and Gavins Point Dam. A total of 51 piping plovers nested during 2002 in the approximately 35-mile National Recreational River stretch from Fort Randall Dam to Lewis and Clark Lake (1.5 per river mile).In the 59-mile unchanneled stretch from Gavin's Point Dam to Ponca State Park 246 plovers nested (4.2 per mile) that year. Additionally, 366 of the 741 (49 percent) terns nesting in the entire upper and middle Missouri system (approximately 1,700 river miles) nested in this unchanneled stretch. The sudden spring water flows also stimulated new riverside growth of cottonwoods and willows, and scoured some new wetlands in the river's floodplain.

By comparison, the Missouri River stretch below Ponca State Park has been channeled, forcing the river into a 600-foot wide bed. This confined channel has resulted in a cutting (incising) effect on the river bed, lowering it by at least ten feet, and a drying up of the floodplain wetlands that once were periodically restored by spring floods (Fowler, 2003).

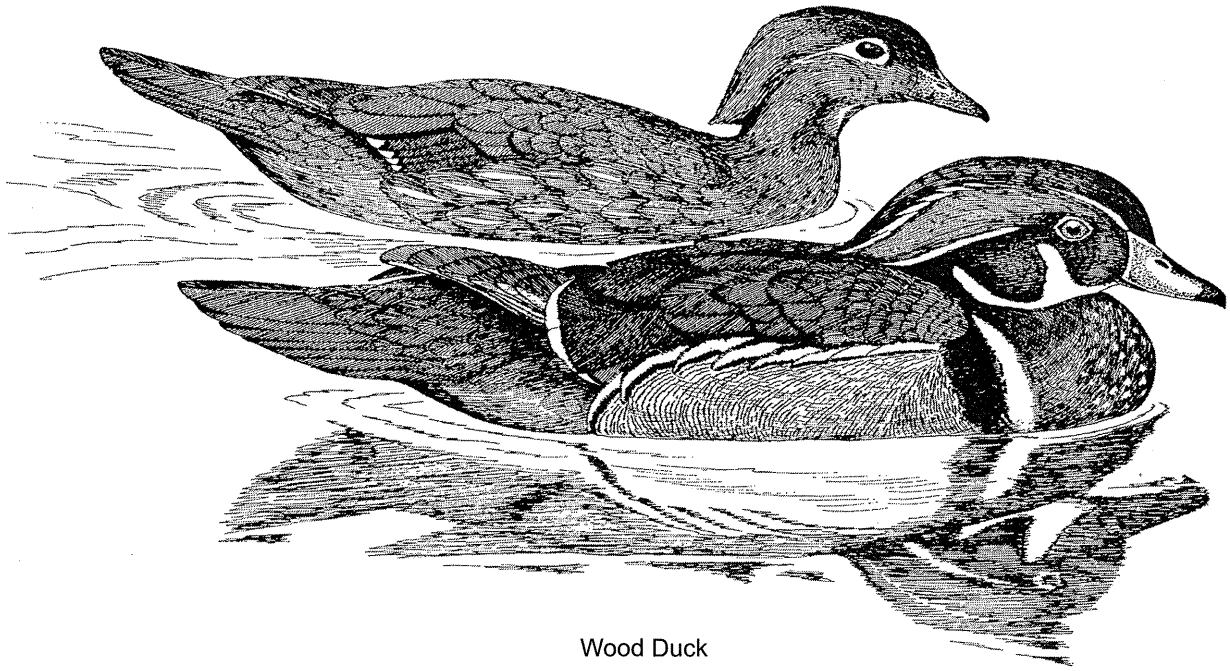
The Water Resources Development Act authorizes the Corps of Engineers to acquire private land from willing sellers, and to restore both aquatic and terrestrial habitat on it, as well as on existing public lands. Given full funding, some 166,000 wetland acres in the Missouri Valley might be restored over the next quarter-century, including 27,000 acres in Nebraska (Fowler, 2003).

Mitigation projects in the Corps of Engineers Omaha District (which includes Nebraska, Iowa and part of northwestern Missouri) have documented 36 species of mammals, 98 birds, 23 reptiles, 12 amphibians and 38 fish within mitigation project areas.

DeSoto Bend National Wildlife Refuge offers some clues as to what good-quality Missouri Valley riverine habitats should resemble. Within its 7,800 acres is a 750-acre oxbow lake that was formed when the Corps of Engineers channeled this part of the river during the 1950's, and which now supports a nice population of both native and introduced fish (see Appendix 4). This lake also attracts up to 70 or more American bald eagles though the winter months (November to March), and until recent years as many as about 700,000 snow geese regularly stopped there during their fall migration. Changing goose migration patterns, mainly involving a major migratory shift west into the corn-rich Platte Valley, have effectively terminated the use of DeSoto Refuge by migrating snow geese, although ducks still use the refuge heavily.

Extensively timbered bottomlands in the refuge support a large population of white-tailed deer, and the riverine wetlands also attract mink, raccoon, muskrat and beaver, as well as more generally distributed coyote, opossum, red fox and many smaller

Fig. 1



Wood Duck

mammals. At least 240 species of birds have been recorded at the refuge, including 81 breeding species.

Weaver (1965) described the original floodplain forests of the Missouri Valley as consisting largely of Plains cottonwoods and willows, the seeds of which are often blown in by the wind. These sand- and mud-adapted plants quickly germinate and colonize sandbars and river edges as the river shifts its course. Sandbar willow is the first of the woody colonizers, and is common around drying lakes, ponds and marshes, often intermixed with cattails and bulrushes. It grows rapidly, forming woody thickets up to about 20 feet high. Peachleaf and black willows are taller (up to 40 feet) trees, but also appear soon along riverbanks and wetland edges. Their seedlings are both shade-intolerant and, together with sandbar willow, are eventually replaced by Plains cottonwoods, which may grow to 70 or more feet in height by the time they are 70–80 years old. When the cottonwoods reach about 100 years of age they are near the end of their lifespans, and are being replaced by other slower-growing and longer-lived hardwoods, gradually increasing the species diversity of these fertile floodplain forests.

In the southeastern part of Nebraska the Missouri floodplain forest reaches its maximum diversity, with black walnut, red and American (white) elms, and green ash all becoming important forest species. Other less common floodplain species are white ash, Kentucky coffee-tree, Ohio buckeye, hackberry, silver maple and sycamore (Weaver, 1965).

The Missouri Valley floodplain forests host several eastern-oriented birds that breed rarely if at all farther west in Nebraska, such as the pileated woodpecker, the yellow-throated vireo, the Kentucky, prothonotary and cerulean warblers, the Louisiana waterthrush and the summer tanager. All told, the southeastern Missouri Valley forests have among the highest breeding bird species diversity of the entire state (Johnsgard,1987), and also hosts several unique species of mammals and reptiles.

Fontenelle Forest Nature Center in Bellevue, Nebraska, consists of about 1,400 acres, much of which lies within the Missouri floodplain. Much of this forest now consists of mature hardwoods, although most of it was once heavily logged, and the river was channelized during the 1930's. Nearby Neale Wood Nature Center, of 562 acres, also borders the river but has more upland acreage. Together these two nature centers contain nearly 500 species of vascular plants, judging from two recently published field guides (Barth

and Ratzlaff, 2004; Ratzlaff and Barth, 2007).

These two sites collectively include approximately 280 species of herbaceous forbs, 60 grasses, 35 trees, 34 sedges and rushes, 24 shrubs and 10 woody vines. These totals include a few introduced and generally weedy species. Many of the sedges and rushes are limited to wetland habitats. Many of the trees (cottonwood, green ash, silver maple, box elder, sycamore, northern catalpa, American and cork elms, peachleaf and black willows, red and white mulberries) are also ecologically associated with the moist floodplain forest. The black willow is at the northern edge of its Missouri valley range here.

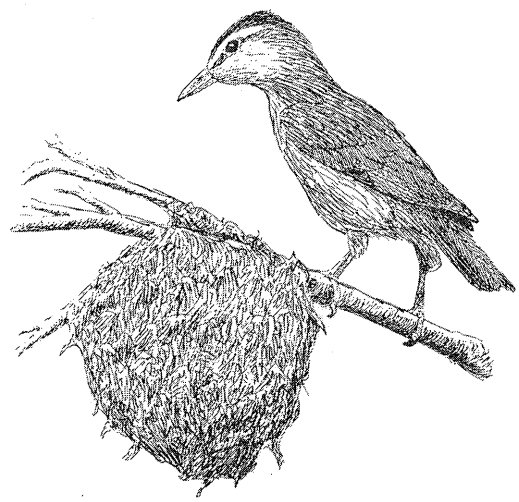
Preserved examples of mature Missouri floodplain forest also exist in northeastern Nebraska at Ponca State Park (843 acres, Dixon County), and in southeastern Nebraska at Indian Cave State Park (3,052 acres, Nemaha and Richardson Counties). Ponca State Park has some northern and eastern biological associations, such as breeding ruby-throated hummingbirds, which are most common in the floodplain forest where nectar-bearing flowers such as spotted jewelweed and wild bergamot are likely to be found. In contrast, Indian Cave State Park supports some southern-oriented forest species such as the western rat snake, timber rattlesnake and southern flying squirrel, as well as several southern trees including the black, blackjack, chinkapin and white oaks.

Natural History Profiles of some Missouri Valley Wetland Species

Muskrat

There are few if any permanent marshes in Nebraska that lack a few haystack-like piles of vegetation scattered about, a certain indication that muskrats are present. Muskrats lack the beaver's trait of dam-building, and their burrowing into human-made impoundments are more likely to cause leaks and damage them than to improve their wetland habitat. But muskrats do regularly cut narrow paths through dense reedbeds, and these passageways are often used by ducks, grebes, and other swimming animals. Their rounded "houses" of reeds, rushes and cattails also make convenient lookout points, nest sites or loafing places for some of these same species.

Fig. 2



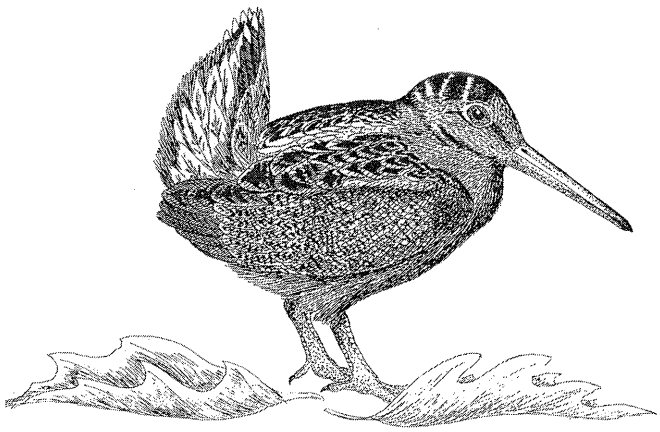
Red-eyed vireo, adult at nest

Muskrats are less than ten percent as heavy as beavers, the adults weighing about 1.7–3 pounds, with the females averaging heavier than the males. Because of their much smaller size, population numbers are far greater than beavers', and under very good conditions their breeding density may exceed thirty animals per acre of marsh. However, there are often substantial annual variations in abundance, and at least in northern parts of their range the species may undergo regular cycles of abundance and scarcity.

Muskrats don't have all the adaptations for diving and social living that beavers exhibit, but do have some similarities. Their hind feet are partly webbed, and their long tail is somewhat flattened vertically and is used as a rudder. They too can remain under water for long periods, up to about 17 minutes, but unlike the beaver they often supplement their herbivorous diet with various animal materials. Like beavers, the animals produce a musky scent from glands in the anal region. This trait is especially typical of males during the breeding season, and is used to mark territories. Also like beavers, muskrats construct shoreline dens with underwater entrances that are difficult to detect visually. Only where banks are unavailable are the above-water "houses" likely to be built. They are usually built of dried cattails, bulrushes and similar vegetation during the autumn, and primarily serve as winter retreats.

Muskrats maintain monogamous pair bonds during the breeding season, and are distinctly territorial. Females will kill intruding females, and males will fight with nearby males. Because of their fairly

Fig. 3



American woodcock, adult

small size, muskrats are favored prey of many predators, especially mink, which often enter their dens to capture and kill them. Otters are another serious aquatic predators. On land, coyotes and raccoons pose survival problems, as do minks and weasels. Larger raptors such as the great horned owl, red-tailed hawk and northern harrier are likewise potential aerial threats.

Given all these enemies, average lifespans are rather short, probably about 3-4 years under natural conditions. Maturity occurs the first year, or even as soon as six months after birth. The usual litter is of 6-8 young, and there may be several litters per year, depending on the length of the breeding season.

American Woodcock

Woodcock are rarely seen except in flight, since they remain "frozen" until the last possible moment before flushing. As they take off, their wings produce a whistling sound, and the combination of a long bill and short tail is distinctive. In spring, the males' nasal peent calls can be heard at dusk, as they get ready to perform their aerial display. In flight display the birds hover on whistling wings, trilling a series of notes that sound like chickaree, chickaree.

The habitats used by woodcocks throughout the year must include locations for displaying, nesting, brood rearing, migration and wintering. Throughout their range and the yearly cycle, woodcocks are generally confined to young forests with scattered openings on poorly drained land. The male's spring singing ground must have a clearing in which the bird can fly, with the size of the clearing directly related to the height of the surrounding trees. Plant life in this clearing is typically of the early woody or low shrubby stage, with some herbaceous cover for alighting.

During migration and through the winter both adults and young forage primarily on earthworms, and are restricted to habitats high in this food source. Shrubby habitats having a herbaceous ground cover support large numbers of earthworms, and thus also of woodcocks, especially where soil moisture is adequate but not extreme, and soil texture favors moisture retention.

Although some of the literature is contradictory on this point, it seems that woodcocks are polygamous if not promiscuous. Males apparently do not assist with brood rearing, and will usually attempt to mate with decoys placed in their singing fields. After their spring arrival on the breeding grounds, males establish territorial singing grounds, from which they exclude other males and at which they perform dawn and dusk song flights. After a long series of tuko and peent calls, the male launches himself into the air, rising in a series of diminishing circles until he is hovering high above the ground. Then, as his wing "twittering" ceases and he begins a zigzag glide toward the ground, he utters a series of liquid trilling notes.

Females are attracted to these singing grounds, and copulation occurs there. Females also utter the peent and tuko notes, but do not perform display flights.

The nest is usually built fairly near the edge of woody cover, and may be in mixed hardwood and conifer growth, in pure hardwood, especially alder, cover, or in old fields or brushy cover. The nest is built entirely by the female, often in sparse cover at the base of a shrub or small tree, or near the edge of a shrub thicket. It ordinarily is within a few hundred feet of a singing ground.

The clutch normally contains 4 eggs, although some late clutches may have only 3. The eggs are laid at a daily rate, and the incubation period of 20-2I days begins after the last egg is laid. During incubation the female is a notoriously "tight" sitter, relying on her effective cam-

ouflage to avoid detection She feigns injury when forced from a hatching nest; and shortly after the chicks are hatched they "freeze" when threatened.

Brood cover is very similar to nesting cover, and must be close to poorly drained areas where the chicks can begin probing for worms. A brooding female performs a labored flight when flushed with her brood and observations of the related European woodcock suggest that she simulates the carrying of a chick between her legs by sharply depressing and fanning her tail feathers.

The young make their first flights when they are about two weeks old, and can fly well by three weeks. Broods probably break up some 6-8 weeks after hatching and apparently the birds gradually migrate southward at low altitude, in loosely scattered flocks. A limited amount of display occurs after the breeding season, and some song flights are initiated on the wintering grounds in December and January. Evidently most woodcocks return to their natal breeding grounds for breeding.

Prothonotary Warbler

This beautiful warbler is known to breed only along the lower Missouri Valley in Nebraska, with probable records extending from Nemaha County north to Douglas County, and possibly to Washington County (Mollhoff, 2001).

The few prothonotary warblers that migrate north to Nebraska to breed arrive after having made a trans-Gulf migration, from the eastern coast of Mexico and the Yucatan Peninsula. On arrival, the birds seek out habitats providing suitable nest sites on or above large bodies of standing or slow-moving water. Fontenelle Forest in Sarpy County is one of the few areas that provide such conditions.

The primary song of males consists of single upslurred and high-pitched notes, repeated 4–14 times, and increasing in amplitude toward the end, and at the rate of about three per second. Males sing throughout the day, often from an elevated perch. The primary function such singing is territorial establishment and defense against conspecific males. Countersinging between males on nearby territories is common, and extended song occurs during interactions with females. Songs may also be accompanied by a flight display.

Territories are centered on one or more nest cavities, in which males place a thick blanket of moss. Depending on population density, they may range from about 1.2 acres to nearly four acres in area. Although usually monogamous, a small percentage of males may be polygynous if there is a super-abundance of nest sites. Pair bonds are maintained through the breeding season and occasionally may extend between seasons (Petit, 1999).

Foods during the breeding season consist of mostly insects such as larval butterflies and moths, flies (including midges), beetles, grasshoppers, ants and spiders, but also some snails and isopods. Foraging by nonbreeding birds is done close to the ground or water, with prey taken from leaves and twigs, the ground, or from spider webs. During the breeding season the sexes may differ some in foraging, with males foraging higher and more often in trees than females, but both sexes mostly glean their prey from leaves, twigs and branches (Petit, 1999).

Females select a nest cavity from, one or several locations that the male is defending and in which he has placed a blanket of moss. The presence of moss may improve hatching success by helping to maintain a stable humidity and temperature within the cavity. Nests are almost always within about 20 feet of standing water, in easily flooded areas, and are typically about six feet of the ground or water surface. The clutch-size is usually 4–5 eggs, laid on a daily basis. Incubation is by the female only, and lasts an average of 12–13 days. Brooding is done by the female only, and fledging occurs 10–11 days after hatching (Petit, 1999).

Marsh Wren

In Nebraska, marsh wrens are largely associated with the Sandhills, but sporadic records extend east to the Missouri River. The eastern edge of the Sandhills may represent the division point separating the eastern form of the marsh wren (*C. p. palustris*) from the western population (*C. p. paludicola*), which perhaps represent two sibling species (Mollhoff, 2001).

Throughout their Nebraska range, marsh wrens are associated with emergent aquatic vegetation, especially cattails and bulrushes. In some other regions phragmites and cordgrass have been used, but cattails seem to provide ideal nesting habitat. At other seasons, such as during migration, a wider variety of habitats are used, but these usually involve wetland situations.

Marsh wrens are mostly insectivorous, often taking very small insects from near, at, or slightly below the water surface. They also consume spiders, but insects such as beetles, flies, moths, bugs and hymenopterans are major food items (Kroodsma and Verner, 1997).

Primary territorial or courtship songs are loud, and sustained, especially in early morning and sometimes even through the night, at least in eastern populations. In Nebraska, some males sing large-repertoire songs typical of western birds, while others sing the lower repertoire eastern song type. Song repertoires in Nebraska may exceed 125 types.

Song rates may reach up to about 20 per minute, with each song lasting one or two seconds. Song rates are especially high during sexual encounters. Song appears to of greater importance as a mate-attraction signal than used significantly in territorial defense. At least in the laboratory, songs of other wrens may be learned, especially those having marsh wren vocal components. After a male is paired, his song rate increases, in contrast to many other songbirds. Song rates are highest during the pre-laying period, when the males constructing new courting nests and trying to attract additional mates (Kroodsma and Verner, 1997).

Male marsh wrens are polygynous, with the percentage of males able to attract more than one mate varying among populations, from about 5–50 percent, and some males acquiring as many as three mates. Like house wrens, marsh wrens are notable for their tendency to destroy the eggs and sometimes the young of other species, including red-winged and yellow-headed blackbirds, and even those of species as large as the least bittern. Destruction of nearby nests probably reduces competition for food around the wrens' own nests (Kroodsma and Verner, 1997).

Males construct many "dummy" nests in addition to those actually used by females; up to as many as 22 nests have been reported. These nests may serve as decoys for nest predators, may serve as an indicator of a male's vigor and territorial quality, and also serve as courtship centers. Eggs are laid daily, with clutch-sizes in the northern plains averaging 5–6 eggs. Incubation lasts 13 days. The male may help feed the nestlings, or may abandon the female and go in search of additional mates. Females require a period of about 45–50 days to complete a nesting cycle, so that a second nesting cycles may begin about six weeks after the first was started (Kroodsma and Verner, 1997)

Sedge Wren

The sedge wren has a seemingly scattered but fairly wide breeding distribution in Nebraska, with possible nesting records along the Missouri Valley extending from Knox County to Douglas County. There are also a few records along the Platte Valley, and some probable or confirmed breedings elsewhere. They are most likely to be found in meadows and marshes with dense sedge stands (Mollhoff, 2001). Sedge wrens are known nesters at DeSoto Bend National Wildlife Refuge.

Although sedge wrens are present in Nebraska from May to September, nearly all the breeding records are for July and August. This curious fact has caused people to speculate that Nebraska's breeding sedge wrens are those that arrive in the state after an earlier breeding cycle elsewhere, presumably to the north. In South Dakota the birds are locally common east of the Missouri River, but there are few confirmed nesting records for the state (Tallman, Swanson and Palmer, 2001). In North Dakota sedge wrens are widespread and common breeders, with most egg records occurring during the period mid-June to early August (Stewart, 1965). This would suggest that successful breeding to the north would not account for Nebraska's nesting phenology, but early failed breeding efforts to the north might.

Nests are built over land or water, usually 1–3 feet above the substrate. Like those of marsh wrens, they are globular structures, with a lateral entrance at the equator, and are lined with plant down, hair or other soft materials. Also like the marsh wren,

males construct numerous "dummy" nests, and have a similar pattern of polygynous mating. In areas of very high densities, as many as ten territorial males might share a meadow of only ten acres.

Males sing almost continuously at the height of the mating season, at the rate of 6–12 songs per minute, and up to 22 hours a day. After a pair bond is formed, the female either selects or initiates a brood nest, which is often lower and harder to locate than are the courting nests. The usual clutch-size is about seven eggs. Females also do all the incubating over the 12- to 14-day incubation period, and perform most of the brooding. After the young fledge, a second breeding effort may be started, although in some areas single brooding appears to be typical (Herkert, Kroodsma and Gibbs, 2001).

THE MISSOURI VALLEY WETLANDS

BURT COUNTY

Burt County is a Missouri River valley county, with 3,200 acres of surface water. The county's area is 493 square miles (averaging 46.5 people per square mile). It contains two state recreation areas and one wildlife management area. Its entire eastern border is bounded by the Missouri River.

Blackbird Bend-Tieville-Decatur Bend W. M. A. See Thurston County.

Middle Decatur Bend W. M. A. Area 133 acres. Missouri River lowland habitats and shoreline access. Located three miles east of Decatur. Lat./Long. 42.0032/-96.20486

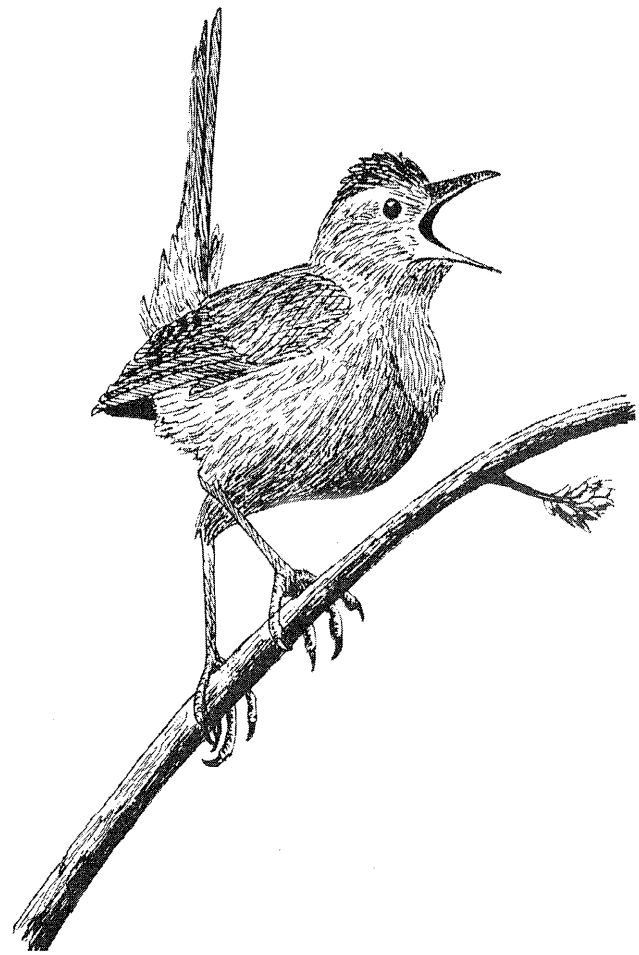
Pelican Point SRA. Area 36 acres. Riverine woodland habitats. Located along the Missouri River, four miles north and one mile east of Tekama. Lat./Long. 41.83331/-96.11269.

URL:http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=223

CASS COUNTY

Cass County is a Missouri River valley county, with about 1,800 acres of surface water. The county's area is 559 square miles (averaging 15 people per square mile). It contains two state parks, two state recreation areas and one wildlife management area. Its entire eastern border is bounded by the Missouri River.

Fig. 4



Marsh wren, adult male

Eugene T. Mahoney State Park. Area 574 acres, with nearly a mile of river frontage. A highly developed riparian park along the Platte River, with some mature floodplain forest. Located 0.5 mile north of I-80 exit 426, or one mile south, two miles east of Ashland (Ph. 402/944-2523). Lat./Long. 41.02601/-96.31223. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=273

Louisville SRA. Area 192 acres. Riverine woods, shallow ponds (50 acres) and about one mile of Platte River frontage. Located one mile west of Louisville. Lat./Long. 41.00583/-96.17064.

Platte River State Park. Area 416 acres. A riparian forest park along the Platte River. Located one mile south and two miles west of Louisville. From I-80, take exit 440 and go 15 miles southeast on NE Highway 50,

and two miles west on NE Highway 66. (Ph. 402/234-2217}. Lat./Long. 40.9926/-96.21073. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=224

R. W. Schilling W. M. A. Area ca. 1,500 acres. Lowlands and excavated wetland at the confluence of the Platte and Missouri rivers. Open year around, with waterfowl tours on Sunday afternoons during fall migration. From Main St. of Plattsmouth drive east over railroad tracks, then take first left on Refuge Road. and continue one mile east. Lat./Long. 41.03363/-95.87493.

Tobacco Bend Mitigation Project. Area 1,604 acres. A Corps of Engineers Missouri River Mitigation Project. Restored Missouri River wetlands and floodplain hardwood forest, encompassing 4.5 river miles (river miles 585.5–590.0). Located one mile south and three miles east of Plattsmouth.

CEDAR COUNTY

Cedar County is a Missouri River valley county, with 3,900 acres of surface water. The county's area is 740 square miles (averaging 13.2 people per square mile). It contains two wildlife management areas and its entire northern border is bounded by the Missouri River.

Chalkrock W. M. A. Area 135 acres, with a 45-acre reservoir. Located four miles south and l.5 mile west of the Missouri River bridge on U.S. Highway 8l. Lat./Long. 42.79762/-97.37711.

Lewis and Clark Lake SRA. and Gavin's Point Dam. Area 33,227 acres, with a 32,000-acre reservoir. The western end of this huge but silting-in Missouri River reservoir is a massive wetland (see Bazile W. M. A., Knox County). Located along the South Dakota boundary, seven miles north of Crofton. Park permit required (Ph. 402/388-4169). Lat./Long. 42.84337/-97.52087. URL: http://www.nwo.usace.army.mil/html/Lake_Proj/gavinspoint/recreation.htmlbn

DAKOTA COUNTY

Dakota County is a Missouri River valley county, with 3,400 acres of surface water. The county's area is 264 square miles (averaging 78 people per square mile). It contains two wildlife management areas and its entire eastern border is bounded by the Missouri River.

Omadi Bend W. M. A. Area 33 acres. Missouri River bottomland forest and an oxbow lake. Located two miles north and three miles east of Homer. Lat./Long. 42.35153/-96.43272.

DIXON COUNTY

Dixon County is a Missouri River valley county, with over 5,000 acres of surface water. The county's area is 476 square miles (averaging 13.6 people per square mile). It contains one state park, two wildlife management areas, and its entire northeastern border is bounded by the Missouri River. Ponca State Park is at the downstream terminus of the Missouri National Recreational River (402/336-3970). It extends from Fort Randall Dam in South Dakota to Niobrara, Nebraska, and from Gavins Point Dam to Ponca State Park, eight miles of Verdigre Creek and the easternmost 20 miles of the Niobrara River.

Buckskin Hills W. M. A. Area 415 acres, with a 75-acre reservoir. Located two miles west and two miles south of Newcastle. Lat./Long. 42.626/-96.92536.

Elk Point Bend W. M. A. Area ca. 400 acres. Riparian wetlands along an unchannelized stretch of the Missouri River. Located about two miles north and two miles east of Ponca State Park (inquire at Park for access directions). A new and still undeveloped W. M. A. Address: P.O. Box 688, Ponca, NE 68770 (Ph. 402/755-2284). Lat./Long. 42.64633/-96.71479.

Ponca State Park. Area 2,166 acres. Extensive mature floodplain and upland forests along an unchanneled stretch of the Missouri River. The Missouri River National Recreational River Resource and Education Center in the park has wetland and other nature exhibits. The regional bird list includes nearly 300 species (one of the state's largest bird lists), of which more than 70 nest locally. Many of these are species associated with the Mis-

souri River's riparian forests. Jon Farrar (2004) listed 43 birds as a "sampler" of the area's bird life, of which most are riparian forest species, as well as some more typical wetland breeding species such as the bald eagle, piping plover, spotted sandpiper and least tern. Located two miles north of Ponca on Spur 26E. (Ph. 402/755-2284). Lat./Long. 42.60962/-96.71727. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=143

DOUGLAS COUNTY

Douglas County is a Missouri River valley county, with 12,800 acres of surface water. The county's area is 331 square miles (averaging 1.496 people per square mile). It contains one state recreation area/wildlife management area, and its entire eastern border is bounded by the Missouri River.

Heron Haven Wetland. Area 25 acres. An urban wetland and educational center. Free admission. Owned by Papio NRD. 11809 Old Maple Road. Omaha, NE. 68164-2639. URL: www.papionrd.org.

Neale Woods Nature Center. Area 554 acres. Mature hardwood forest, restored prairie, wetlands and Missouri River floodplain woods. The local bird list includes 190 species, with 57 known or probable breeders. Located at 14323 Edith Marie Ave., Omaha (402/453-561). Admission fee. URL: http://www.fontenelleforest.org/history.html

Two Rivers SRA./W. M. A. Combined area 955 acres, with 329 water acres. Platte River floodplain forest (one mile of river frontage), marshes, and croplands. Located four miles south and two miles east of Waterloo, or one mile south and one mile west of Venice. State park entry permit required for SRA. (Ph. 402/359-5165). Lat./Long. 41.21677/-96.35175. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=175

KNOX COUNTY

(see also the Niobrara Valley Region)

Knox County is a Niobrara–Missouri River valley county, with over 41,000 acres of surface water, mostly consisting of reservoir acreage. The county's area is 1,108 square miles (averaging 8.0 people per square mile). It contains one state park, six state recreation areas, two wildlife management areas, and its entire northern border is bounded by the Missouri River and the impounded Lewis and Clark Lake.

Niobrara State Park. Area 1,632 acres. A hilltop state park overlooking the marsh-like confluence of the Niobrara and Missouri rivers at the western end of Lewis & Clark Lake. Includes floodplain, grasslands and upland woods on bluffs. A regional bird list encompassing Cedar and Knox counties as well as the park includes 259 species. Jon Farrar (2004) listed 70 birds as a "sampler" of the area's bird life, of which 34 are typical wetland species including five herons and ten shorebirds. The list also includes 21 riparian or upland forest species, including nine woodland warblers, with probable breeders such as the American redstart and black-and-white warbler. Located one mile west of Niobrara on State Highway 12. State park entry permit required (Ph. 402/857-3373 or 402/471-1414). Lat./Long. 42.74998/-98.06724.

NEMAHA COUNTY

Nemaha County is a Missouri River valley county, with nearly 1,800 acres of surface water. The county's area is 409 square miles (averaging 16.6 people per square mile). It contains part of one state park (Indian Cave), one state recreation area, and its entire eastern border is bounded by the Missouri River.

Indian Cave State Park. See Richardson County.

Kansas Bend Mitigation Project. See Otoe County.

Langdon Bend Mitigation Project. Area 1,312 acres. A Corps of Engineers Missouri River Mitigation Project, including four miles (river miles 522.8–531.4) of restored Missouri River floodplain. Located one mile east of Nemaha.

OTOE COUNTY

Otoe County is a Missouri River valley county, with 2,500 acres of surface water. The county's

area is 616 square miles (averaging 25.1 people per square mile). It contains one state recreation area, one wildlife management area, and its entire eastern border is bounded by the Missouri River.

Hamburg Bend W. M. A. Area 1,544 acres. A Corps of Engineers Missouri River Mitigation Project, under Game & Parks Commission management. It encompasses more than four river miles (miles 551.6–555.9), including restored Missouri River floodplain. Located one mile east of Minersville, or three miles south and five miles east of Nebraska City. Lat./Long. 40.59315/-95.76712.

Kansas Bend Mitigation Project. Area 1,056 acres. A Corps of Engineers Missouri River Mitigation Project, with six river miles of ecologically restored Missouri River floodplain (river miles 541.2–547.2). Located eight miles east of Julian, and extending into Nemaha County.

Missouri River Basin Lewis and Clark Interpretive Trail and Visitor Center. Area 80 acres. An historic interpretive center overlooking the Missouri River, with a forest trail down to the heavily wooded floodplain. Located at southeastern edge of Nebraska City off U.S. Highway 2; 100 Valmont Dr. (Ph. 402/874-9900). URL: http://www.mrb-lewisandclarkcenter.org/

RICHARDSON COUNTY

Richardson County is a Missouri River valley county, with over 1,600 acres of surface water. The county's area is 554 square miles (averaging 15, 5 people per square mile). It contains part of one state park, one state recreation area, two wildlife management areas, and its entire eastern border is bounded by the Missouri River.

Indian Cave State Park. Area 3,399 acres. Includes three water acres, and over three miles of Missouri River frontage. Botanically diverse, with about 2,400 acres of Missouri River floodplain and upland woods, plus native grasslands. The channelized river here has been modified by the Corps of Engineers to slow the current and provide better aquatic habitat. Jon Farrar (2004) listed 60 birds as a "sampler" of the area's bird life, of which most are riparian forest species, as well as some more typical wetland species such as wood duck and prothonotary warbler. Located two miles north and five miles east of Shubert (Ph. 402/883-2575). Lat./Long. 40.264/-95.56964. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=91

Kinters Ford W. M. A. Area 200 acres. Riverbottom woods along south fork of the Big Nemaha River, plus grassland and cropland. Located seven miles south and two miles west of Humboldt. Lat./Long. 40.05681/-95.99797.

Margrave W. M. A. Area 106 acres. Marshland, riparian woods, cropland and grassland along the Big Nemaha River. Located three miles south and seven miles east of Falls City. Lat./Long. 40.01459/-95.46832.

SARPY COUNTY

Sarpy County is a Missouri–Platte River valley county, with about 2,500 acres of surface water. The county's area is 241 square miles (averaging 604 people per square mile). It contains one state recreation area. Its entire eastern border is bounded by the Missouri River, while its western and southern sides are bounded by the Platte River.

Chalco Hills Recreation Area and Wehrspan Lake. Area 1,200 acres, with a 245-acre flood-control reservoir and adjoining wetlands. Wehrspan wetland is located at the south end of Wehrspan Lake. This wetland protects Wehrspan Lake from excessive runoff, and is a joint project of the Papio–Missouri River N. R. D. and the Corps of Engineers. Free admission. Located one mile north and one mile west of I-80 exit 440. Address: 154th St. & Giles Road (Ph. 402/444-6222). URL: http://www.papionrd.org/recreate/chalco.htm

Fontenelle Forest Nature Preserve. Area 1,300 acres. Mature Missouri riparian hardwood forest, including several wetlands, 17 miles of footpaths, and a nature center. Jon Farrar (2004) listed 40 birds as a "sampler" of the area's bird life, of which most are riparian

forest species, as well as some more typical wetland species such as the northern and Louisiana waterthrushes. The combined Fontenelle Forest-Neale Woods bird list includes more than 250 species, with more than 100 potential breeders. There are nearly 80 water-dependent birds, plus more than 90 species variably associated with floodplain forests. Admission fee (Ph. 402/73l-3140). Address: 1111 Bellevue Blvd., Bellevue, NE. URL: http://www.fontenelleforest.org/history.html

Gifford Point. Area 1,700 acres. Missouri river-bottom forest, and a 400-acre environmental farm. Located east of Fontenelle Forest. Address: 700 Camp Road, Bellevue, NE (Ph. 402/597-4920).

Neale Woods Nature Center. See Douglas County.

Schramm Park SRA. Area 340 acres. Extensive wooded Platte River riparian habitats (0.75 mile of river frontage) and an interpretive center–aquarium. This park and nearby Platte River State Park (see Cass County) are among the best places in the lower Platte Valley for finding such uncommon to rare eastern riparian forest bird species as the ovenbird, Louisiana waterthrush, Kentucky warbler, summer tanager and scarlet tanager. Jon Farrar (2004) listed 38 birds as a "sampler" of the lower Platte's bird life, of which most are riparian forest species. It includes all of the just-mentioned species, as well as some more typical wetland birds such as green heron, bald eagle, piping plover and least tern. Located six miles south of I-80 exit 432, or eight miles south of Gretna. State park entry permit required (Ph. 402/332-3901). Lat./Long. 41.02403/-96.25092. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=158

THURSTON COUNTY

Thurston County is a Missouri River valley county, with about 1,500 acres of surface water. The county's area is 394 square miles (averaging 18.2 people per square mile). Its entire eastern border is bounded by the Missouri River.

Blackbird Bend-Tieville-Decatur Bend W. M. A. 3,861 acres. A Corps of Engineers Missouri River Mitigation Project, now under Nebraska Game & Parks management. Restored Missouri River wetlands and lowland hardwood forest, encompassing 3.2 miles of shoreline (river miles 693.8–697.0). Located from 0.5 mile east of Decatur (in Burt County), extending north about four miles on the Nebraska side to Blackbird Hill in Thurston County.

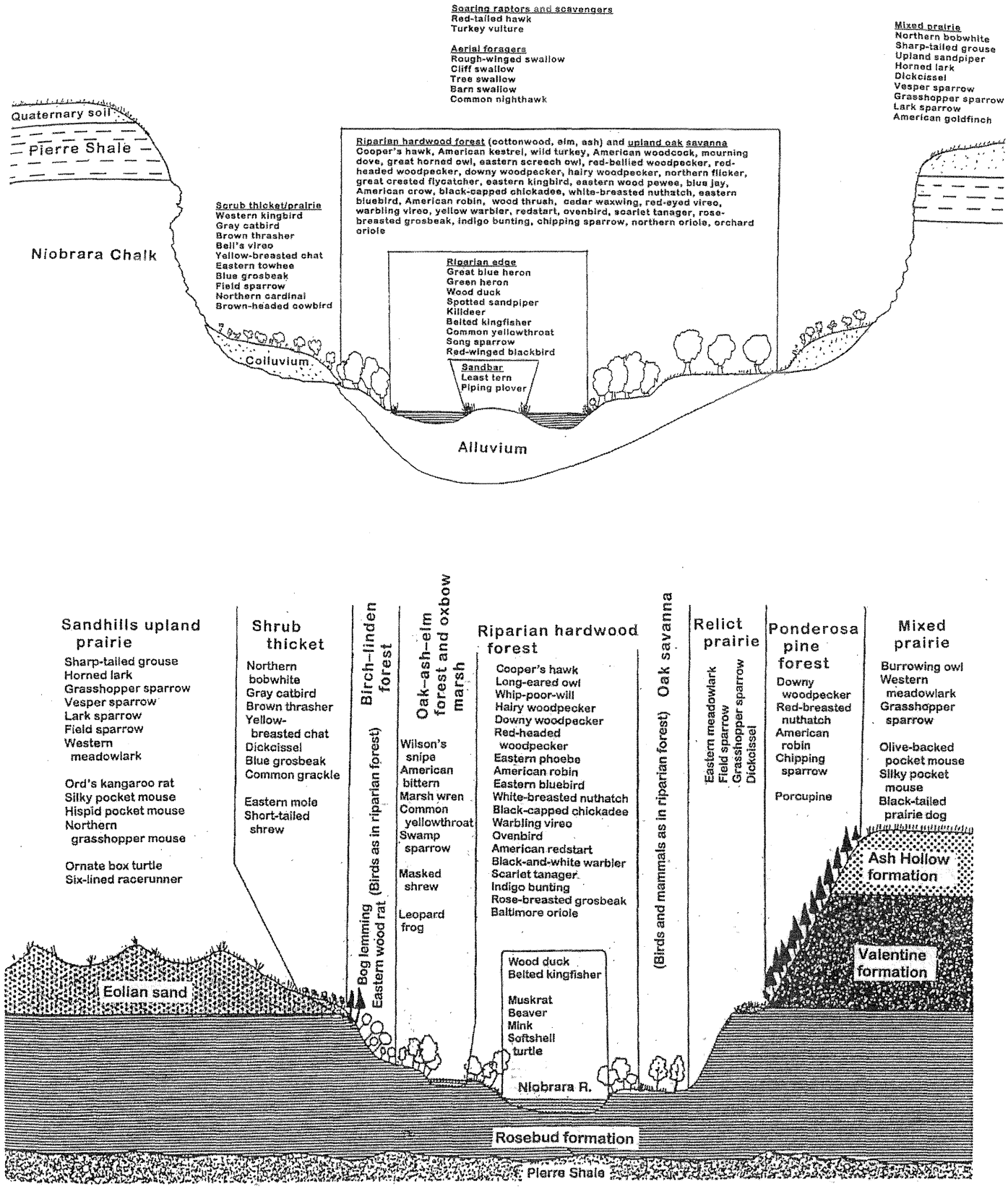
WASHINGTON COUNTY

Washington County is a Missouri River valley county, with over 3,000 acres of surface water. The county's area is 391 square miles (averaging 50.6 people per square mile). It contains two national wildlife refuges, and its entire eastern border is bounded by the Missouri River.

Boyer Chute National Wildlife Refuge. Area 3,100 acres. Riparian woods and grassy lowlands along three miles of the Missouri River, with a restored 2.5-mile chute that follows an earlier channel and has modified river flows so as to more closely resemble pre-channelized conditions. Extensive wetland habitat restoration, including the planting of nearly 10,000 native plants. Located three miles east of Fort Calhoun. A federally owned wildlife refuge, managed from DeSoto National Wildlife Refuge (Ph. 402/468-4313). URL: http://midwest.fws.gov/desoto/boyerbro.html

DeSoto National Wildlife Refuge. Area 7,823 acres. Riverine deciduous forest along the Missouri River, a seven-mile-long oxbow lake (DeSoto Lake), and uplands. The refuge bird list includes 240 species, of which at least 99 are wetland species. Located five miles east of Blair on U.S. Highway 20, mostly on the Iowa side of the Missouri River. A federally owned wildlife refuge; daily admission fee (Ph. 712/642-4121). URL: http://midwest.fws.gov/desoto/dsotobro.html

Fig. 5



Cross-section view of typical central Niobrara Valley habitats, and some associated vertebrates. After Johnsgard (2007).

Chapter 3

The Niobrara Valley Region

The Niobrara River is Nebraska's most scenic river, and the only one that has cut its channel down to bedrock, making it rich in outcrop exposures that reveal its geologic history. It is also a favorite destination for canoeists, who delight in maneuvering through the sometimes swirling waters and occasional rapids.

In its lowest reaches, the Niobrara flows directly over Pierre shale, a blackish sedimentary layer that was deposited 70–80 million years ago, near the end of the Cretaceous period, and in a larger sense near the end of the Mesozoic era. Progressively more recent sedimentary layers are stacked above, the Rosebud, Valentine and Ash Hollow formations successively encapsulating the tens of millions of years between the end of the Mesozoic era (65 million years ago) and the start of the Pleistocene (the period of continental glaciations, beginning 1.8 million years ago).

The Niobrara River cut down through these relatively soft layers of sand, gravel and siltstone fairly rapidly, probably between 12,000 and 5,000 years ago, producing a canyon that is locally up to several hundred feet deep (Maher, Engelmann and Shuster, 2003). As a result, and in marked contrast to Nebraska's other rivers, in its middle and lower reaches the Niobrara's floodplain is very narrow, and is flanked by steep canyon walls. The river also lacks meanders, oxbows, or other floodplain wetlands as it flows over a bedrock substrate. The wetland habitats in the Niobrara Valley throughout its overall Nebraska 486-mile length have been estimated at about 30,000 acres (Johnsgard, 2007).

The lowest reaches of the Niobrara River, from about the confluence of the Keya Paha and Niobrara Rivers to the Niobrara's mouth, are marked by a rather broad valley, with the river flowing over a thick layer of shale, and with fairly broad floodplains. Species diversity of vertebrates is relatively high here **(Fig. 1).** The floodplain is clothed with a fairly wide variety of trees, shrubs and herbaceus plants, most of which have their biogeographic origins in the Missouri Valley. Wetlands are best developed in the marshy bottomlands where the Niobrara merges with the now-impounded Missouri River at Lewis & Clark Lake.

To the west, the floodplain becomes narrower and the banks steeper, with forest communities surviving in the more shaded sites, such as along stream-fed side canyons. Wooded habitats become progressively rarer in these increasingly arid and more western environments.

Near the western end of the state, in Dawes County, the Niobrara's floodplain is scarcely more than a half-mile wide, and the river channel no more than 40 feet wide (Weaver, 1965). However, across the entire stretch of its Nebraska route the valley has become a major east-west passageway for the distributional expansions of many plants and animals, and is one of the Great Plains most important "suture zones" connecting eastern and western biotas (Johnsgard, 2007).

Wetland habitats are quite limited in westernmost Nebraska, which at the state's border are only about 40 miles from the river's headwaters in eastern Wyoming. The uppermost stretch of the Niobrara in Sioux County of western Nebraska is little more than a creek that in some places may be jumped across, such as at Agate Fossil Beds National Monument near Harrison.

Some typical wetland birds occurring and probably breeding at Agate Fossil Beds National Monument include the Canada goose, killdeer, northern harrier, upland sandpiper, long-billed curlew, great blue heron American bittern, short-eared owl, marsh wren, yellow-breasted chat, common yellowthroat and red-winged blackbird (National Park Service, 1980; Farrar, 2004). Wetland birds known to breed within the Sioux County stretch of the Niobrara River additionally include the wood duck, mallard, blue-winged

teal, sora, Wilson's phalarope, belted kingfisher, cliff swallow and barn swallow (Mollhoff, 2001).

As the river flows eastwardly, it passes through an area of Nebraska Sandhills, but where it has encountered heavier substrates it has cut a fairly deep canyon from eastern Cherry County eastward for about 75 miles. Because of its remarkable scenic beauty and relatively unaltered conditions, this region has been designated as a National Scenic River.

The best information available on the breeding birds of the National Scenic River stretch of the central Niobrara Valley comes from a bird list of the Fort Niobrara National Wildlife Refuge and from the Nebraska Breeding Bird Atlas (Mollhoff, 20001). Based on these sources, known or probable wetland non-passerine breeders in the National Scenic River stretch of the Niobrara River from eastern Cherry to eastern Keya Paha counties include Canada goose, wood duck, gadwall, mallard, blue-winged teal, northern shoveler, northern pintail, great blue heron, northern harrier, killdeer, piping plover, spotted sandpiper, upland sandpiper, long-billed curlew, Wilson's snipe and least tern. Passerine birds (typical songbirds) include the barn swallow, cliff swallow, Bell's vireo, marsh wren, common yellowthroat, swamp sparrow, bobolink, red-winged blackbird and yellow-headed blackbird.

A 1977 study sponsored by the Bureau of Reclamation of the birds of the proposed Norden Dam area of the Niobrara valley in Keya Paha County was performed by Longfellow (1977). Harrison (1980) used these data to identify 48 of the breeding-season or permanent resident species as typical of the river and its bordering forests. Probable floodplain forest nesters in this group include the yellow-billed and black-billed cuckoos, red-headed, hairy and downy woodpeckers, northern flicker, eastern and Say's phoebes, eastern and western wood-pewees, red-breasted nuthatch, house wren, gray catbird, wood thrush, eastern bluebird, yellow-throated, warbling and red-eyed vireos, ovenbird, American redstart, eastern towhee, rose-breasted and black-headed grosbeaks, lazuli and indigo buntings, and orchard and Baltimore orioles. I have deleted a few species of unproven and unlikely regional breeding status from Harrison's list, and some of the remainder (such as the gray catbird and buntings) are as much forest-grassland edge species as they are forest-nesters.

Mammals of the Fort Niobrara National Wildlife refuge were documented and analyzed ecologically by Beed (1936). Mammals identified as being part of the emergent aquatic vegetation community included the raccoon, mink and muskrat, while the wet meadow community also included the raccoon and mink, plus the meadow vole, North American deermouse, northern short-tailed shrew, and prairie shrew. Streamside forest mammals identified by Beed included the elk, coyote, raccoon, spotted skunk, long-tailed weasel, least weasel, mink, fox squirrel, eastern cottontail, northern short-tailed shrew, prairie shrew, North American deermouse, meadow jumping mouse and eastern mole.

Reptiles and amphibians of the Fort Niobrara National Wildlife refuge were also analyzed ecologically by Beed (1936). Those associated with the open water and shore community included the northern leopard frog, Blanchard's cricket frog, boreal chorus frog, tiger salamander, snapping turtle, painted turtle, spiny softshell, Graham's crayfish snake and northern water snake. Emergent aquatic community herps included northern leopard frog, Blanchard's cricket frog, boreal chorus frog, bullfrog, Graham's crayfish snake and northern water snake. Wet meadow herps included the northern leopard frog, Blanchard's cricket frog, boreal chorus frog, tiger salamander, Graham's crayfish snake and northern water snake. Streamside forest herps included the northern leopard frog, Great Plains toad, six-lined racerunner, bullsnake, Plains garter snake, eastern racer and prairie rattlesnake. A cross-sectional diagram of the geology, plant communities and vertebrates of the central Niobrara Valley is presented in (**Fig. 2.**)

The plants of The Nature Conservancy's Niobrara Valley Preserve have also been well documented. An early botanical survey of the Preserve region was performed by Harrison (1980), and later important botanical papers include those by Kaul, Kantak, and Churchill (1988), Kantak and Churchill (1993) and Kantak (1995). Tolstead (1942) also did a detailed ecological analysis of

the plants somewhat farther upstream, in northern Cherry County. Many of the important biogeographic aspects of the plants occurring within this region and documentd by these authors have already been summarized by Johnsgard (2007).

Tolstead's description of so-called "swamp" vegetation growing along river meanders, oxbows and sandy lakes of the central Niobrara Valley is instructive. He noted that the plants in such sites are able to tolerate water fluctuations up to about three feet, with common reed, hardstem bulrush, lacustrine sedge, common cattail and common arrowhead increasingly more able to survive such fluctuations. Some plants such as roundleaf money-flower, water-cress, brookgrass and water parsnip grow partly submerged along spring-fed streams where the water temperature and flows are fairly constant throughout the year.

Known or probable wetland breeding birds in the lowest stretch of the Niobrara River from eastern Holt County to the Missouri River confluence in Knox County are numerous. Non-passerine wetland species include the Canada goose, wood duck, mallard, blue-winged teal, northern shoveler, pied-billed grebe, great blue heron, American coot, piping plover, killdeer, spotted sandpiper, upland sandpiper, Wilson's snipe, American woodcock, least tern and belted kingfisher. Passerines often associated with these wetlands include the Bell's vireo, cliff swallow, barn swallow, common yellowthroat, marsh wren, swamp sparrow, bobolink, red-winged blackbird and yellow-headed blackbird (Ducey, 1989, Mollhoff, 2001; personal observations).

Ducey (1989) listed 107 known or suspected currently breeding birds for the vicinity of the Niobrara's mouth, as compared with 89 breeding species in the Fort Niobrara, Niobrara Valley Preserve region of the central Niobrara Valley. Some of these additional species include such floodplain forest- and thicket-adapted birds as the eastern screech owl, long-eared owl, willow flycatcher, brown creeper and warbling vireo. A few distinctly western floodplain forest species also extend variably eastward toward the Niobrara–Missouri confluence, such as the Bullock's oriole, together with hybrid combinations involving its eastern-oriented relative, the Baltimore oriole **(Fig. 3)**. At least 268 bird species have been reported from the Niobrara Valley from the Wyoming–Nebraska border to the river's mouth **(Table 4).**

As the Niobrara River merges with the upper end of Lewis and Clark Lake, it dumps huge quantities (about 1,400 acre-feet, or 2.9 million tons) of sediment annually. This sediment includes about two million tons of sand, and the rest is a mixture of silt and clay, These sediments have produced a huge marsh-like delta at the upper end of the lake, adding to the substantial amounts of sediments brought in by the Missouri River.

As a result of these sediments, by early in the 21st century the roughly 50-year old reservoir had lost more than 20 percent of its 575,000 acre-foot capacity, and it may be entirely filled with sediments by 2075 (Fowler, 2003). This sedimentation process has raised the local groundwater table, partially flooding the nearby town of Niobrara, and reducing the flood-carrying capacity of the river channel (Mussetter & Wolf, 1993).

As of 2011 the reservoir had already shrunk to about half of its original 30-mile length (Gene Zuerlein, pers. comm.). By 2075 it will probably provide little more than a wonderful albeit extremely expensive habitat for shorebirds and marsh birds. The vast expanse of marshy habitat represented by Bazile Creek Wildlife Management Area on the Nebraska side, and Lewis and Clark State Recreation Area on the South Dakota side, comprise what is probably the largest area of prime wet meadow and emergent marshland habitat in this part of the state. It has not yet been studied for possible breeding by such probable but elusive nesting species as the sora and Virginia rail, or the American and least bitterns.

Natural History Profiles of some Niobrara Valley Wetland Species

American Coot

To a greater degree than any other of the North American rails, the coot is closely associated with fairly deep ponds and relatively open water through-

out the year. Its ecology is thus more like that of diving ducks than of typical rails, and like some diving ducks it eats largely submerged vegetation obtained by diving. It also feeds on shorelines, both on vegetable matter and, at least during summer, to a moderate extent on insects and aquatic animal life.

During spring migration the distribution of coots is broad and limited mainly by the availability of submerged aquatic plants at suitable depths for foraging. Requirements for the establishment of breeding territories additionally include emergent nesting vegetation such as cattails and bulrushes, as well as open water for foraging and territorial patrolling.

The life and social activities of coots revolve largely around territorial defense during their entire adult life. The birds are evidently wholly monogamous, with a long courtship period and a permanent pair bond, although new mates may be acquired rapidly after the loss of a partner. Success in obtaining a mate is associated with an individual male's success in acquiring and holding a territory. Small winter territories, or core areas, are held by males on the wintering grounds, where courtship occurs.

In regions where the birds winter on their breeding grounds this core area may simply be expanded to form a nesting territory. In Nebraska, a nesting territory is established after arrival on the breeding area. This larger area, usually an acre or more in size, must include emergent vegetation suitable for providing nesting material and anchoring the floating nest. Within this area the male constantly patrols his territorial borders, performing a series of aggressive displays and attacking intruders.

Coots have an array of calls for individual recognition, courtship, alarm, warning, and intimidation. A cocked-tail display following fights with other coots is typical, while the usual aggressive response toward other species is a spread-wing "swanning" posture. Courtship displays include billing, nibbling, and bowing.

During their reproductive cycle, coots build a variety of structures, including nest-like display platforms on which copulation occurs, nests for incubating their eggs, and brood nests. Each male normally bring nesting materials to his mate, who constructs the nest. Eggs are laid at nearly daily intervals, and clutches vary in size from five to almost a dozen, depending on season and location. Incubation begins before the clutch is complete and both sexes participate, with the male doing the majority of it.

The incubation period is 23 days, with the chicks hatching over several days. Typically the female leads the first of the chicks to hatch away from the nest and begins to feed them, while the male remains behind to care for the later hatchlings. After eight or more have hatched, the male usually leaves the nest, with his share of the brood, and abandoning any unhatched eggs. The young are initially fed by the parents, but soon begin to forage for themselves, and after a month or so are nearly independent. They begin to fly at about 75 days of age, but may occasionally resort to begging food from their parents nearly up until that time.

As the chicks mature, the parents become increasingly intolerant of them, and may expel them from their territory even before they are fledged. In some areas a second clutch is begun after the first brood has dispersed.

Swamp Sparrow

Swamp sparrows differ from most of Nebraska's wetland breeding birds, in that the majority of the nesting records have come from the eastern half of the Sandhills region, west to eastern Cherry and Thomas counties. Swampy areas, such as those dominated by false indigo and willows, are preferred over herbaceous emergent species, such as cattails, bulrushes, sedges, and arrowhead. Outside the Sandhills there are very few breeding records, with possible breeding reported from along the Niobrara River in Brown County and in the Niobrara drainage in Sheridan County (Mollhoff, 2001). The swampy backwaters of Lewis and Clark Lake are very likely to be an important nesting area for swamp sparrows, but because of the relative difficulty of finding nests, relatively few regional breeding records have been obtained.

Over their entire North American breeding range,

the presence of water seems to be a universal habitat requirement of breeding by swamp sparrows. In one study it was found that three requirements exist: shallow standing water, low and dense cover (up to about five feet high), and elevated song-posts. Vegetation within breeding territories varies from sedge and cattail communities to those that consist mostly of medium to tall shrubs (Mowbray. 1997).

Foods taken during the breeding season include a variety of arthropods, such as larval and adult damselflies and dragonflies, beetles, ants, bees and aphids. Foraging is frequently done on the ground, in shrubs and the lower parts of trees, as well as along the edges of open water. After the breeding season their foods shift to the usual granivorous sparrow diet of seeds, such as those of sedges, smartweeds, and various grasses.

During the breeding season, males establish territories, with their density varying greatly with habitat quality, and range from two to more than 60 territorial males per five acres (two hectares). Territorial boundaries are delineated by the locations of singing posts, and usually show no overlap with those of other marsh-nesting passerine birds such as song sparrows and marsh wrens.

Territories are announced by male song, with the primary song being a loud, extended series of seemingly single-syllable notes, although each syllable consists of 2–5 very short notes that collectively produce a trill lasting 2–3 seconds. Flight songs are also sometimes uttered, although much less frequently than is perched or primary song. These have a distinctive cadence and tonality, and consist of a completely different set of note components than those used during the male's primary song (Mowbray. 1997).

Males are mostly monogamous, although some cases of bigamy have been reported. Pair bonds form only a week or two after the females arrive on the breeding grounds, which may be 2–3 weeks after the males have appeared. Nest-building begins very soon, with nest sited over ground or water, and often supported by shrubs, sedges or cattails. Clutch-sizes average about four eggs, and if the nest is destroyed a new nest and clutch may be started within a few days. The incubation period lasts 12–14 days, and nestlings leave the nest 9–13 days after hatching (Mowbray, 1997).

Baltimore and Bullock's Orioles

Two of the closely related species that come together and sometimes hybridize along the Platte and Niobrara Valleys are the Baltimore and Bullock's orioles. Studies on these birds in Nebraska during the 1950s led Charles Sibley and Lester Short Jr. to conclude that the birds had not been separated geographically long enough during the Pleistocene period to develop a complete reproductive isolation between their respective gene pools. Then, when climatic and vegetational changes in the Great Plains allowed these two forms to again come into contact, hybridization began to occur and to threaten the genetic integrity of the two incompletely differentiated gene pools. More recent studies have indicated that the incidence of hybridization may have declined since then, causing taxonomists to again consider them as distinct, albeit occasionally hybridizing, species.

Adult male Baltimore and Bullock's orioles are among the most attractive of Great Plains birds. It takes males two years to gain their full nuptial plumage, although first-year males are sexually fertile, since they sing and display to generally unresponsive females whenever they get an opportunity. First-year males also occasionally manage to mate and raise young. However, their plumage is very female-like, and their songs are also rather distinctive. Most inexperienced birders can never imagine these drab males are exactly the same species as the much more brilliantly colored older ones that might be perched nearby. However, females can certainly distinguish young males, and their plumage differences might be an important means of making mate decisions, along with the rather strongly apparent age-related male plumage differences.

Females of both species are quite similar, and it is unlikely that males discriminate between them when courting. In an area of eastern Colorado where both species occur, pairs of Baltimore orioles were more successful in breeding than were pairs of Bullock's or hybrid pairs. Although hybrids are certainly fertile, adult males have a variety of generally

intermediate, odd-looking plumages, and they also may have maladaptive molt patterns. Thus, rather than molting their wing feathers once after breeding, they may molt twice, according to the different seasonal molt schedules of each. If generally true of hybrids, this might be a strong selective pressure against the production of second-generation hybrids. Observations suggest that Bullock's orioles may be more tolerant of heat and have lower water requirements than do Baltimore Orioles, a point of possible ecological significance in the West.

In Nebraska, both species are prone to nest in the same trees as do eastern or western kingbirds, taking advantage of the kingbird's intense nest-protection behavior against jays, crows, or other possible aerial predators of eggs and nestlings.

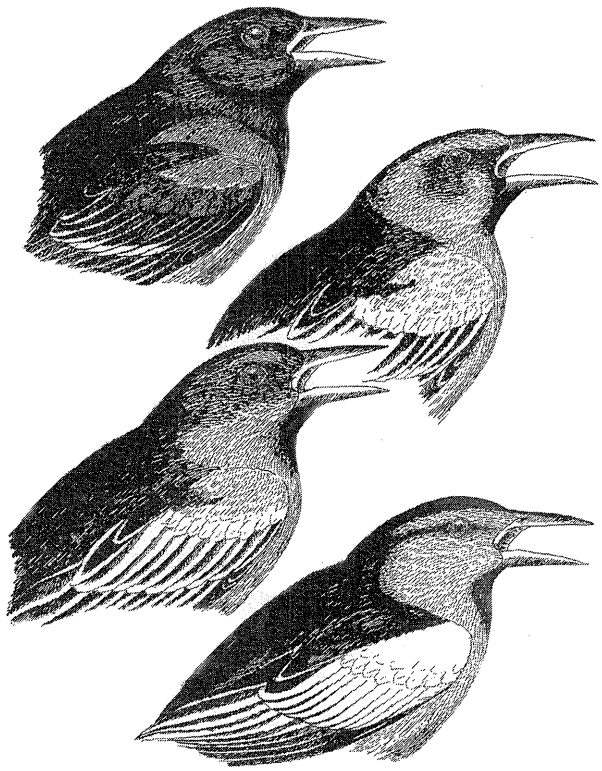
Bobolink

Bobolinks and hay meadows or wet meadows are certainly the favorite nesting habitats for this grassland bird, with tallgrass prairies perhaps equally suitable. As such, it is especially widely distributed along the Niobrara, Loup and Platte valleys, and throughout the Sandhills region. It also occurs in tallgrass prairie remnants in eastern Nebraska (Mollhoff, 2001). Generally in much of Nebraska the birds are to be found in wet meadows with a mixture of native grasses and forbs, especially meadows that are sub-irrigated in the Sandhills region.

During the breeding season bobolinks forage mainly on the ground, searching for seeds and both larval and adult insects. Insect taxa commonly eaten during summer include lepidotperans, coleopterans, and orthopterans. Rice and other grains comprise a large part of their foods on their South American wintering grounds (Martin and Gavin, 1995).

After arrival on their breeding areas, male bobolinks become highly territorial, using a variety of vocal and postural displays to announce and defend their territories. Their songs are complex and extended, and include two major types. Each is comprised of 25-50 vocal elements, uttered in a highly stereotyped fashion. Within a single small population several dialects in the song structure may be evident. Most males utter their two song types in random order, either while perched or in flight. Perched songs are often performed from the highest point in the territory, such as overhead wires, trees, or other tall vegetation.

Fig. 6



Comparison of breeding male plumages of Baltimore (top) and Bullock's (bottom) orioles and two hybrid combinations. After Johnsgard (2007).

Postural displays include a song-spread posture, with both wings extended, the head bowed, and the white-feathered areas and golden nape feathers raised. During song flights the head is raised, white scapular feathers lifted, and the tail lowered, exposing the white rump. Song flights are often performed in a generally circular route over the territory, with the wings rapidly moving and directed downwards, barely reaching the horizontal at the top of the upbeat (Martin and Gavin, 1995).

Males are strongly polygamous, attracting as many as four females within a single territory, although one or two mates would seem to be the most common pairing pattern. Pair bonds form rapidly after spring arrival, and last until the end of the breeding cycle. If their nest is destroyed, a pair may renest, or the female sometimes seeks out a new mate. Extra-pair copulations and associated fertilizations are common, especially among older females when they are pair-bonded to younger males.

The nest is located on the ground, often in fairly moist locations, and typically is at the base of large forbs. Only the female builds the nest. Following nest destruction a new nest is built, rather than re-using the first one. The clutch-size is usually of five eggs, deposited daily. Incubation by the female begins with the laying of the penultimate egg. Hatching occurs after 12-13 days. Males participate in brooding duties, except in the case of polygamous males, who then turn their attention to other females.

By late June, flocks of mixed sexes and ages begin to form, and by mid-August they begin to gravitate to freshwater marshes, seeking out wild rice if it is available. Eventually the birds migrate several thousand miles to Brazil and Argentina, where they also inhabit mashes, grasslands, and fields of sorghum and rice (Martin and Gavin, 1995).

THE NIOBRARA VALLEY WETLANDS

BOYD COUNTY

Boyd County is a Niobrara River valley county, with about 2,500 acres of surface water. The county's area is 540 square miles (averaging 4.1 people per square mile). Boyd County lies entirely within the Missouri National Recreational River region, which extends from the South Dakota border east to eastern Dixon County. Boyd County contains two wildlife management areas. Its entire southern border is bounded by the Niobrara River, while its northern side is bounded by the Missouri River.

Hull Lake WMA. Area 36 acres, with a three-acre lake. Located three miles south and one mile west of Butte. Lat./Long. 42.86698/-98.88138.

Parshall Bridge WMA. Area 230 acres. Riparian woods along the Niobrara River. Located five miles south of Butte. Lat./Long. 42.84811/-98.84746.

BROWN COUNTY

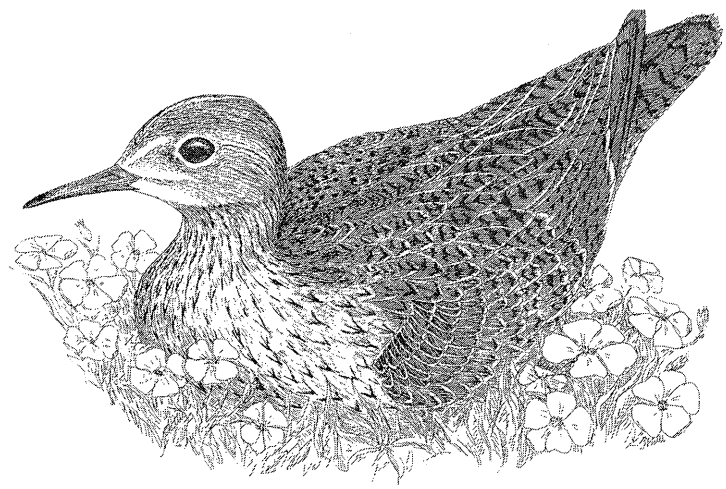
(see also Sandhills Wetland Region)

Brown County is a Niobrara River valley and Sandhills county, with about 8,000 acres of surface water. The county's area is 1,221 square miles (averaging 2.8 people per square mile). Brown County lies entirely within the Niobrara National Scenic River region, which extends west into Cherry County and east into Keya Paha County. Brown County contains three state recreation areas, six wildlife management areas, and its entire northern border is bounded by the Niobrara River.

Niobrara Valley Preserve. Area ca. 56,000 acres. This Nature Conservancy preserve includes about 25 miles of Niobrara River frontage, and adjoining floodplain and uplands, which lie within a relatively narrow ecological transition zone connecting eastern deciduous forest and western coniferous forest biotas. The preserve's bird list totals some 186 species, with 75 known breeders. Wetland species include wood duck, green heron, Virginia rail, piping plover, least tern, upland sandpiper, long-billed curlew, Wilson's snipe, American woodcock, belted kingfisher, Bell's vireo, common yellowthroat, yellow-breasted chat, song and swamp sparrows, and bobolink. Along the 25 miles of riparian forests many eastern- and western-oriented bird species co-exist. Eastern-oriented riparian birds include the whip-poor-will, eastern screech-owl, eastern wood-pewee, eastern phoebe, eastern bluebird, northern mockingbird, scarlet tanager, eastern towhee, rose-breasted grosbeak, indigo bunting and Baltimore oriole. Western-oriented riparian forest species include the spotted towhee, black-headed grosbeak, lazuli bunting, blue grosbeak, and Bullock's oriole. Some local hybridization between eastern and western congeners probably occurs, such as among the towhees, bunting and orioles. Jon Farrar (2004) listed 86 birds as a "sampler" of the area's bird life, of which nearly 50 were forest and forest-edge species, as well as 16 more typical wetland species. There are also at least 43 species of mammals, 17 reptiles, 8 amphibians, 24 fish and 130 aquatic invertebrates, (Kantak & Churchill, 1993). The plant list includes 581 vascular plant species, and at least 80 species of mosses and liverworts (Churchill, Freeman and Kantak, 1988). These totals are indicative of the unusually high bio-

logical diversity of the location. Owned by The Nature Conservancy, and located 12 miles north of Johnstown (Ph. 402/722-4440). URL: http://nature.org/wherewework/northamerica/states/nebraska/preserves/art9162.html

Fig. 7



Upland sandpiper

CHERRY COUNTY

(See also Sandhills Wetland Region for Sandhills sites)

Cherry County is a Sandhills and Niobrara River valley county, with about 41,000 acres of surface wetlands. The county's area is 5,718 square miles (averaging 1.0 people per square mile). Eastern Cherry County is at the western end of Niobrara National Scenic River region, which extends east nearly 80 miles into Keya Paha County. Cherry County is Nebraska's largest county, and contains two national wildlife refuges, one national forest, one state park, one state recreation area and nine wildlife management areas. Its entire east-west width is crossed by the Niobrara River. The region in the vicinity of Valentine National Wildlife Refuge is in the geographic center for the Sandhills' most extensive and biologically rich wetlands. Western Cherry County encompasses the headwaters of the Snake, North Loup, Middle Loup and Dismal rivers.

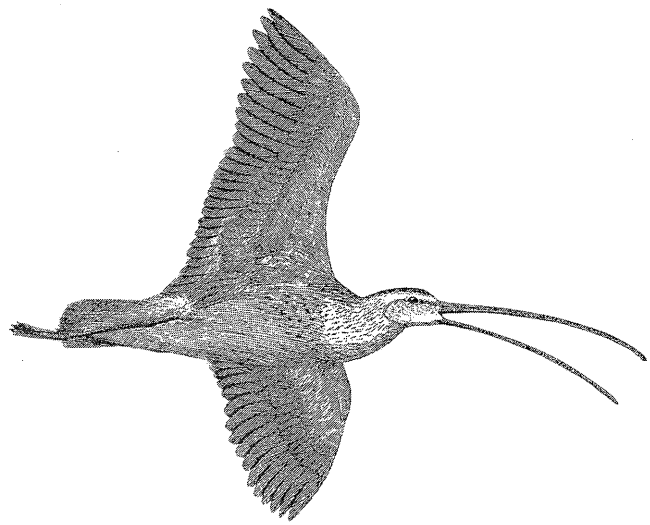
Anderson Bridge WMA. Area 137 acres. Includes a mile of Niobrara River frontage, with riparian woods and a small marshy wetland. From Kilgore drive south 5.5 miles, east two miles, and south five miles. Lat./Long. 42.78656/-100.93496.

Fort Niobrara National Wildlife Refuge. Area 19,122 acres. Includes about 4,350 acres of mostly riparian woods and 375 acres of wetlands. Riparian hardwood forest along the Niobrara River and upland Sandhills prairie, with some spring-fed ponds. The refuge bird list includes 230 species, many of which are riparian woodland forms with primarily eastern zoogeographic affinities. Notable wetland species include the wood duck, upland sandpiper, and long-billed curlew, while riparian or floodplain forest species include eastern screech-owl, whip-poor-will, eastern wood-peewee, great crested flycatcher, eastern bluebird, American redstart, brown thrasher, blue grosbeak and the western-oriented black-headed grosbeak. The most abundant neotropical migrant birds nesting in the refuge area are the common yellowthroat, red-eyed vireo, ovenbird and black-and-white warbler (Anderson, Becker and Gibson, 2004). A sharp-tailed grouse blind is available on a first-come basis. Located about five miles east of Valentine on State Highway 12 (Ph. 402/376-378). URL: http://fortniobrara.fws.gov/.

Merritt Reservoir SRA. Area 9,064 acres, including a 2,917-acre reservoir and 6,147 surrounding acres of Sandhills. The reservoir provides about 44 miles of sandy shoreline when full, and irrigates over 34,000 acres. Riparian woods and wetlands are present along the Snake River below Merritt Dam. Spring-summer birds include woodland edge species such both lazuli and indigo buntings,

and late summer–fall water birds include the trumpeter swan, common loon, three grebes and migrant shorebirds. The Snake River below the dam (privately owned as of 2011) is a prime fishing location for bald eagles in late fall and winter. Located 20 miles southwest of Valentine on State Highway 97. State park entry permit required (Ph. 402/376-3320). Lat./Long. 42.60175/-100.88588. URL: http://www.outdoornebraska.gov.

Fig. 8



Long-billed curlew

Schlegel Creek WMA. Area ca. 600 acres. Includes two miles of Schlegel Creek and associated riparian habitats. Located ten miles south and three miles west of Valentine. Lat./Long. 42.71831/-100.61276.

Smith Falls State Park. Area 260 acres, with ten water acres. Niobrara Valley habitats, with a walking bridge over the Niobrara River to the park's extensive riparian woods (including a relict Pleistocene-age stand of paper birch) and Smith Falls, at 70 feet Nebraska's highest waterfall. The park's birds are probably identical to those of the adjacent Niobrara Valley Preserve (see Brown County, in Sandhills Wetland region). Located 15 miles east of Valentine on U.S. Highway 12, then four miles south of Sparks on marked county road. State park entry permit required (Ph. 402-376-1306). Lat./Long. 42.88822/-100.31526. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=308

DAWES COUNTY

Dawes County is a Niobrara River valley county, with nearly 3,000 acres of surface water. The county's area is 1,396 square miles (averaging 6.2 people per square mile). It contains one national forest, one national grassland, two state parks (Chadron and part of Fort Robinson), one state recreation area and one wildlife management area. Its east-west width is crossed by the Niobrara River and the White River crosses much of the county from southwest to northeast.

Box Butte Reservoir SRA. Area 2,200 acres. A 1,600-acre reservoir on the Niobrara River, lined with willows and cottonwoods. Summer irrigation activities leave large exposed mudflats, which are highly attractive to shorebirds. Located 12 miles east of Marsland, or 9.5 miles north of Hemingford. State park entry permit required (Ph. 308/763-2940). Lat./Long. 42.45567/-103.11284. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=31

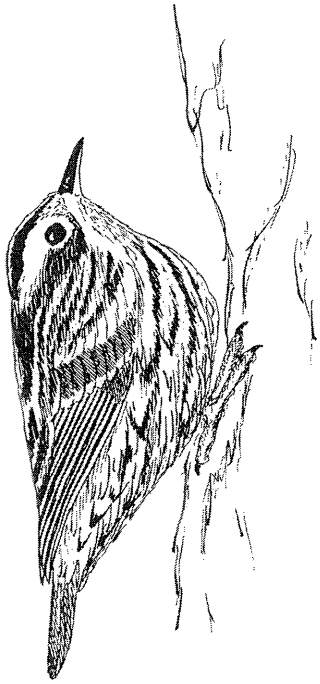
Fort Robinson State Park. Partly in Sioux County (see Sioux County description).

Oglala National Grassland. Area ca. 95,000 acres. A few small, temporary wetlands can often be found in this vast region of federally-owned shortgrass prairie, managed by the Forest Service. Located seven miles north of Crawford on State Highway 71. Address: Nebraska and S. R. McKenzie National Forest, 125 N. Main St., Chadron, NE 69337 (Ph. 308/432-0300). URL: http://www.fs.fed.us/r2/nebraska.

Soldier Creek Wilderness. Area 7,794 acres. This federally owned area has some wetland

habitat along Soldier Creek, but is mostly arid grassland and pine forest. Located eight miles west of Crawford, Part of the Pine Ridge National Recreation Area of the National Forest Service. Address: Pine Ridge Ranger District, Nebraska National Forest, 125 N. Main St., Chadron, NE 69337 (Ph. 308/432-0300). URL: http://www.fs.fed.us/r2/nebraska.

Fig. 9



Black-and-white warbler

Whitney Inlet WMA. Area ca. 900 acres. A small meadow wetland exists at the inlet of an irrigation reservoir (Whitney Lake) on the White River. Located two miles northwest of Whitney. Lat./Long. 42.78603/-103.32354.

KEYA PAHA COUNTY

Keya Paha County is a Niobrara River valley county, with about 1,300 acres of surface water. The county's area is 773 square miles (averaging 1.2 people per square mile). It contains one wildlife management area, and its entire southern border is bounded by the Niobrara River.

Thomas Creek WMA. Area 1,154 acres. Wooded creekbottom along almost a mile of Thomas Creek. Located three miles south and two miles east of Springview. Lat./Long. 42.76684/-99.68877.

Niobrara Valley Preserve. See Brown County.

KNOX COUNTY

(see also Missouri Valley region)

Knox County is a Niobrara–Missouri valley county, with over 41,000 acres of surface water. The county's area is 1,108 square miles (averaging 8.0 people per square mile). Knox County lies almost entirely within the Missouri National Recreational River region, which extends east to eastern Dixon County. Knox County contains one state park (Niobrara), six state recreation areas, one wildlife management area, and it northern border is bounded by the Missouri River.

Bazile Creek WMA. Area ca. 4,900 acres. Riparian woods, grasslands, and extensive heavily vegetated marshland. Extends for nine miles along the area where the Missouri River becomes impounded by Lewis & Clark Lake. Located northeast of Niobrara. Turn north (toward the river) off U.S. Highway 12 at the school in Niobrara, then go east on a road paralleling the river. Or, go north off State Highway 12 about three miles east of Niobrara, at a sign indicating directional access to a boat ramp. Lat./Long. 42.80666/-97.8964.

Gavin's Point Dam & Lewis & Clark Lake SRA. See Cedar County (in Missouri Valley Region, Chapter 2).

Greenvalle WMA. Area ca. 200 acres. Riparian woods along Middle Verdigre Creek. Located ten miles west and three miles south of Verdigre. Lat./Long. 42.54032/-98.2204.

Niobrara State Park. Area 1,632 acres. Riparian woods and grassy uplands along the lower Niobrara River Valley. Located west of Niobrara, above the confluence of the Niobrara River and the impounded backwaters of the Missouri River. A bird list encompassing the park and all of Cedar and Knox counties contains 259 species, of which 104 are water-dependent and many more are floodplain forest species. Jon Farrar (2004) listed 70 birds as a "sampler" of the area's bird life, of which many are riparian forest species. The list also includes 34 typical wetland species such as wood duck, bald eagle, osprey (not known to nest as of 2012), sora, Virginia rail, piping plover, least tern, marsh wren, and common yellowthroat. State park entry permit required (Ph. 402/857-3373). Lat./Long. 42.74998/-98.06724. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=126

SIOUX COUNTY

Sioux County mostly consists of reservoirs. a north-facing escarpment (the Pine Ridge) that is largely covered by ponderosa pine forest and streamside deciduous woodlands that total some 68,000 acres. The county's area is 2,067 square miles (averaging 0.7 people per square mile). Very little standing water is present, but the headwaters of the northward-flowing White River are located here, and the headwaters of the Niobrara River are only about 50 miles west, in eastern Wyoming. Sioux County contains one national monument, one national grassland, one federal wilderness, part of one state park, one state recreation area and one wildlife management area. Its southwestern corner is crossed by the Niobrara River, and it encompasses the headwaters of the White River.

Agate Fossil Beds National Monument. Area ca. 2,000 acres. Shortgrass plains, with some marshland and riparian scrubland along the Niobrara River. A few riverine wetlands are present, and support birds such as upland sandpipers and long-billed curlews. At least 156 bird species have been reported, including such western-oriented upland species as ferruginous hawk, mountain plover, burrowing owl, white-throated swift, Cassin's kingbird, pinyon jay, Townsend's warbler, western tanager, black-headed grosbeak and lazuli bunting. Jon Farrar (2004) listed 33 birds as a "sampler" of the area's bird life, which include a few typical wetland species such as the great blue heron and northern harrier. Located 24 miles south of Harrison on State Highway 29 (Ph. 308/668-2211). URL: http://www.nps.gov/agfo/

Fort Robinson State Park. Area ca. 22,000 ac., including 68 water acres. Riparian woodlands amid shortgrass prairie and pine forests. Although still supporting some ponderosa pine forest habitat, a forest fire in 1989 destroyed 48,000 acres in the Pine Ridge region, including much of the park's forests. Several small ponds are present, and some riparian habitat occurs along the streams. Lewis's woodpeckers are sometimes found among the large streamside cottonwoods. Located three miles west of Crawford on U.S. Highway 20, extending east into Dawes County. State park entry permit required (Ph. 308/665-2900). Lat./Long. 42.68664/-103.49412. URL: http://www.stateparks.com/fort_robinson.html.

Gilbert-Baker WMA. Area 2,537 acres. This area of Pine Ridge uplands is mostly ponderosa pine forest, with grassland along the forest fringes. Little water is present, but Monroe Creek traverses the area though a scenic canyon. Riparian woodlands line the stream, and a two-acre trout pond is present. Floodplain trees include both the eastern Plains cottonwood and the western lance-leaf cottonwood, plus some other localized Rocky Mountain hardwoods such as mountain birch and mountain maple. Located five miles north of Harrison along State Highway 15. Lat./Long. 42.75739/-103.93339.

Table 3

Breeding and Migrant Wetland and Woodland Birds of the Niobrara River Valley*

Wetland, Shoreline & Wet Meadow Species

Snow goose 3 –
Canada goose 3, 1 (EC)
Tundra swan 3 –
Wood duck 4, 4 (E, EC, C, W)
Gadwall 4 –
American wigeon 3 –
Mallard 6, 6 (A)
Blue-winged teal 6, 5 (E, EC, C, W)
Northern shoveler 6 –
Northern pintail 3 –
Green-winged teal 5 –
Redhead 3 –
Lesser scaup 3 –
Common goldeneye 3 –
Hooded merganser 3 –
Common merganser 4 –
Ruddy duck 4 –
Greater prairie-chicken 4, 4 (E, EC)
Pied-billed grebe 2 –
Eared grebe 3 –
American white pelican 6 –
Double-crested cormorant 5 –
American bittern 3 –
Great blue heron 9, 9
Cattle egret 3 –
Green heron 6, 6
Black-crowned night-heron 4 –
Bald eagle 5 –
Northern harrier 7 –
Virginia rail 3 –
Sora 4 –
American coot 5. 1 (E)
Sandhill crane 3 –
Whooping crane 3 –
Piping plover 5, 5 (E, EC)
Killdeer 10, 10 (A)
Spotted sandpiper 7, 7 (E, EC, WC, W)
American avocet 4 –
Solitary sandpiper 3 –
Willet 4 –
Lesser yellowlegs 5 –
Upland sandpiper 8, 8 (A)
Long-billed curlew 6, 6 (EC, C, WC, W)
Semipalmated sandpiper 5 –
Least sandpiper 5 –
White-rumped sandpiper 3 –
Baird's sandpiper 5 –
Pectoral sandpiper 5 –
Stilt sandpiper 4 –
Long-billed dowitcher 3 –
Wilson's snipe 5, 3 (EC, WC, W)
Wilson's phalarope 4 –
Franklin's gull 4 –
Ring-billed gull 4 –
Forster's tern 5 –
Least tern 4, 4 (E, EC)
Black tern 4 –
Short-eared owl 5, 2 (EC)
Belted kingfisher 9, 9 (A)
Bell's vireo 8, 8 (E, EC, C, WC)
Northern rough-winged swallow 8, 8 (A)
Bank swallow 6, 6 (EC, W)
Cliff swallow 7, 7 (E, EC, W)
Barn swallow 10, 10 (A)
Marsh wren 5, 5 (E, EC, C, W)
Common yellowthroat 9, 9 (A)
Yellow-breasted chat 8, 8 (E, EC, C, W)
Savannah sparrow 5, 2 (EC, W)
Song sparrow 5, 1 (E)
Bobolink 7, 6 (E, EC, WC, W)
Red-winged blackbird 10, 10 (A)
Yellow-headed blackbird 7, 2 (C, W)
Eastern meadowlark 3, 1 (E)

Cont. Next Page

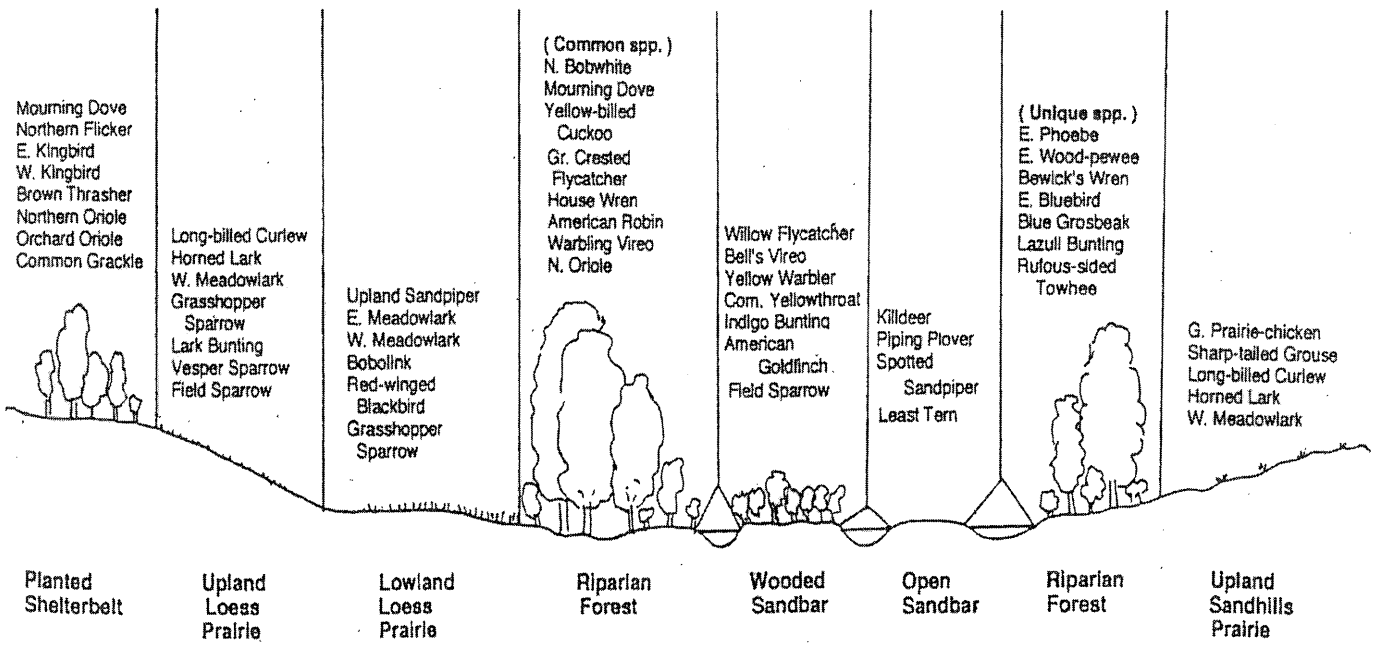
Table 3, cont.

Riparian & Upland Woodland Species

Northern bobwhite 8, 7 (E, EC, C)
Wild turkey 7, 7 (A)
Red-tailed hawk 8, 8 (A)
Swainson's hawk 6, 3 (EC, C, W)
American kestrel 8, 8 (A)
Mourning dove 9. 9 (A)
Black-billed cuckoo 6, 6 (E, EC, C, W)
Yellow-billed cuckoo 9, 9 (A)
Eastern screech-owl 7, 7 (A)
Great horned owl 7, 7 (A)
Long-eared owl 3, 1 (EC)
Whip-poor-will 3, 2 (E, EC)
Red-headed woodpecker 9, 9 (A)
Red-bellied woodpecker 5, 2 (E, EC)
Downy woodpecker 9, 9 (A)
Hairy woodpecker 7, 3 (E, EC)
Northern flicker 10, 10 (A)
Eastern wood-pewee 3, 2 (E, EC)
Least flycatcher 3, 2 (EC)
Eastern phoebe 6, 5 (E, EC, C, W)
Say's phoebe 6, 3 (EC, W)
Great crested flycatcher 7, 6 (E, EC, C, WC)
Western kingbird 10, 10 (A)
Eastern kingbird 9, 9 (A)
Warbling vireo 5, 4 (EC, W)
Philadelphia vireo 3 –
Red-eyed vireo 8, 8 (A)
Blue jay 9, 9 (A)
American crow 9, 8 (A)
Tree swallow 5, 2 (E, EC)
Black-capped chickadee 9, 9 (A)
Red-breasted nuthatch 4, 2 (EC, C)
White-breasted nuthatch 8, 7 . EC, (EC, WC)
House wren 10, 10 (A)
Golden- crowned kinglet 3 –
Ruby-crowned kinglet 4 –
Eastern bluebird 6, 5 (E, EC, W)
Mountain bluebird 3 –
Townsend's solitaire 3 –
Gray-cheeked thrush 3 –
Swainson's thrush 6, 1 (EC)
Wood thrush 5, 4 (E, EC)
American robin 9, 9 (E, EC, C, W)
Gray catbird 9, 9 (A)
Northern mockingbird 4, 3 (EC, WC, W)
Brown thrasher 10, 10 (A)
European starling 4, 4 (E, EC, WC, W)
Cedar waxwing 6, 3 (E, EC, W)
Tennessee warbler 4 –
Orange-crowned warbler 3 –
Yellow warbler 9, 9 (E, EC, WC, W)
American redstart 5, 5 (E. EC, W)
Yellow-rumped warbler, 5 –
Blackpoll warbler 3 –
Black-and-white warbler 5, 4 (EC, C)
Ovenbird 5, 4 (E, EC, C, W)
Mourning warbler 3 –
Wilson's warbler 4 –
Eastern/Spotted towhee 10, 10 (A)
American tree sparrow 3 –
Chipping sparrow 8, 8 (A)
Field sparrow 6, 5 (E, EC, W)
Scarlet tanager 5, 3 (E, EC)
Western tanager 3 –
Northern cardinal 4, 4 (E, EC, C)
Rose-breasted grosbeak 7, 7 (E, EC, W)
Black-headed grosbeak 5, 5 (EC, C, W)
Lazuli bunting 3, 3 (EC, W)
Indigo bunting 7, 7 (E, EC, C, WC)
Brewer's blackbird 3, 2 (W)
Common grackle 9, 9 (A)
Brown-headed cowbird 9, 9 (A)
Orchard oriole 9, 9 (A)
Baltimore/Bullock's oriole 9, 9 (A)
American goldfinch 9, 9 (A)
Red crossbill 4 –
Pine siskin 3, 1 (EC)
House sparrow 5, 5 (E, EC, W)

*Data of Ducey (1989), who determined that an overall total of 268 species have been reported and 126 species have bred in the Niobrara Valley during historic times. Ducey divided the valley into five east-to-west geographic regions as follows: East (river mouth west to Niobrara), East-Central (vicinity of Niobrara Valley Preserve and Fort Niobrara National Wildlife Refuge), Central (central and western Cherry County), West-Central (Sheridan County) and West (Box Butte Reservoir west to Agate Fossil Beds). The first numbers listed above indicate the total number of regions where the species reported during each of the three time periods analyzed (pre-1920, 1921–1960, and post-1960), for a maximum possible score range of 1–15, No species scored above 10, and species scoring below 3 were excluded from this table. The second numbers indicate the total number of regions where breeding has been reported for each of the three time periods analyzed; again no species scored above 10. The final symbols (A = All regions, E = East, EC = East-Central, C = Central, WC = West-Central, W = West) indicate all the regions where breeding was reported by Ducey at any time throughout the study period.

Fig. 10



Central Platte Valley habitats and vertebrates.
(Platte Valley, Chapt. 4)

Chapter 4

The Platte Valley Region

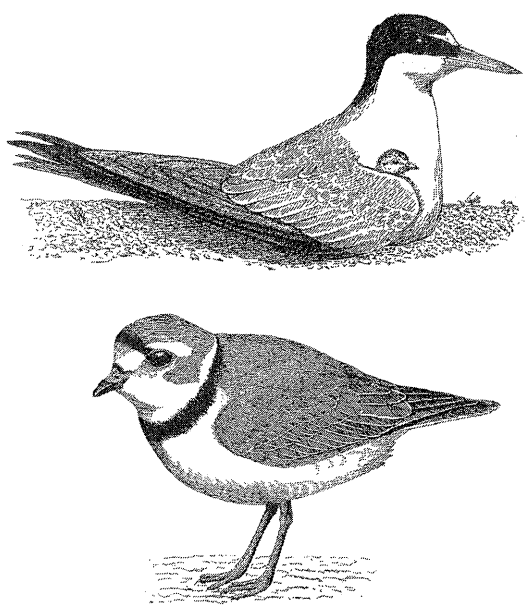
The Platte River is Nebraska's most iconic river. It arises annually, born by the snowmelt among the alpine peaks of the Colorado and Wyoming Rockies, and gathers strength as it sweeps across the plains of these states. It then crosses Nebraska from west to east in a leisurely fashion, providing much of the water used for the state's irrigation-based agricultural economy, drinking and industrial water for many of its larger cities, and wetlands for its wildlife.

In contrast to the Niobrara Valley, the floodplain of the Platte is over ten miles wide over much of its Nebraska length, and at least historically its channels were a maze of intersecting and dividing channels, producing a classic braided river configuration. In still earlier times, the prehistoric Platte River wandered over much of the state. During late Pliocene times (about 2.5 million years ago) the river flowed north almost to the present-day Niobrara Valley. Later glacial action in what is now eastern Nebraska produced moraines and ice lobes that shifted the river's course southward almost to the border of present-day Kansas (Maher, Engelmann and Shuster, 2003). It is likely that over much of this vast span of time the Platte provided as much or more of a haven for wetland wildlife as it does today.

The central Platte Valley is one of North America's most important wetlands, providing critical spring stopover habitat for the endangered whooping crane, and nesting habitat for two other nationally listed (threatened or endangered) species, the threatened piping plover and the endangered interior race of the least tern. It also supports nearly 500,000 sandhill cranes and ten million migrating waterfowl during spring. Lingle (1994) listed 300 bird species for the central Platte Valley, of which about 115 are nesters, and 120 might be described as wetland-dependent species. The history and ecology of the entire Platte Valley has been described by the U. S. Fish and Wildlife Service (1981) and more recently by Johnsgard (2008).

The Platte is Nebraska's longest river, stretching (including the North Platte) an east-west distance of more than 450 miles, from Wyoming to the state's eastern boundary, where it flows into the Missouri River at Plattsmouth. In Nebraska the Platte is a sand-bottom stream having constantly shifting beds. As a result, the predominant early succession trees are ones that tolerate a sandy substrate and a high water table, such as the Plains cottonwood and various flood-tolerant willows. As the river approaches its eastern limits the plant and animal life mostly consists of eastern taxa, as is true of the lower Platte from Fremont downstream. Just west of Fremont is an historic Pawnee sacred site named Pahaku, which represents a western botanical outpost of several eastern plant species.

Fig. 11



Brooding interior least tern (above) and piping plover, adult

Because of Pahaku's rich Pawnee history and its transitional location, linking the eastern deciduous forest plants and the state's prairie riverine forests, Ty Harrison, a UN-L botanist, did an ecological analysis of the site's plants in 1984. He found that several eastern deciduous forest trees (bitternut hickory, black walnut and American linden) approach or reach the western edge of their Platte Valley distribution at Pahaku. Several eastern woodland vines (carrion flower, bristly greenbrier, eastern virgin's bower and Virginia-creeper) and wood-

Table 4

Relative Breeding Season Abundance (in descending sequence) of Central Platte Riparian Woodland Birds. *

Gray catbird 541
Orchard oriole 420
Baltimore oriole 296
House wren 284
American goldfinch 281
Brown thrasher 217
Warbling vireo 207
Yellow warbler 189
Song sparrow 141
Field sparrow 132
American robin 117
Spotted towhee 98
Swainson's thrush 94
Willow flycatcher 88
Brown-headed cowbird 82
Common yellowthroat 68
Black-capped chickadee 68
Northern flicker 63
Orange-crowned warbler 60 (migrant)
Eastern kingbird 44
Northern cardinal 44
Spotted sandpiper 43
Least flycatcher 43 (migrant)
Clay-colored sparrow 43 (migrant)
Common grackle 42
Blue jay 41
Bell's vireo 41
Red-winged blackbird 36
Downy woodpecker 36
Great crested flycatcher 32
Chipping sparrow 30
White-crowned sparrow 30 (migrant)
Alder flycatcher 25 (migrant)
Eastern bluebird 23
Eastern towhee 23
Bullock's oriole 23
Grasshopper sparrow 21
Swamp sparrow 21
Rose-breasted grosbeak 21
Mourning dove 18
Tennessee warbler 14 (migrant)
Tree swallow 13
European starling 13
Cedar waxwing 13
Red-eyed vireo 12
Yellow-rumped warbler 12 (migrant)
American redstart 12
White-breasted nuthatch 10
Yellow-breasted chat 9
Red-headed woodpecker 8
Killdeer 9
Hairy woodpecker
Black-headed grosbeak 8
Ovenbird 7 (migrant)
Northern bobwhite 7
Northern rough-winged swallow 6
Bank swallow 6
Indigo bunting 6
White-throated sparrow 6 (migrant)
Savannah sparrow 5
Red-bellied woodpecker 5
Northern waterthrush 5 (migrant)
Wilson's warbler 5 (migrant)
Mourning warbler 3 (migrant)
Blue grosbeak 3
Belted kingfisher 2
Ruby-crowed kinglet 2 (migrant)
Eastern wood-pewee 2
Eastern phoebe 2
Blackpoll warbler 2 (migrant)
Harris's sparrow 2 (migrant)
Dickcissel 2

* Based on 2001–2004 spring and summer banding, Dawson County. Numbers indicate capture totals; single-capture records are not included. Data from Scharf, 2007)

land wildflowers (jack-in-the-pulpit, columbine, pale touch-me-not, white snakeweed and American bellflower) have similar eastern floodplain forest affiliations and range limits. Pahaku also supports several eastern forest-adapted animals, such as the eastern fox squirrel and white-tailed deer.

Farther west there is an increasing occurrence of Rocky Mountain species. The drier climate and an associated absence of a shaded forest understory increasingly prevents many eastern plants from thriving and reproducing. For example, in central Nebraska's Buffalo County the tree species along the Platte are still able to support the Plains cottonwood, bur oak, green ash, box elder, white elm, hackberry and several willows. About 150 miles farther west, in Deuel County the box elder, white elm and bur oak are lacking (Weaver, 1965). A hybrid population ("Lanceleaf cottonwood") between the Plains cottonwood and its Rocky Mountain replacement, the narrowleaf cottonwood, appear in Scotts Bluff County, which there supports a floodplain mix of willows, box elder, green ash and hackberry (Weaver, 1965). Ponderosa pine extends east along the North Platte from Wyoming to Nebraska's Morrill and Cheyenne counties, as does mountain mahogany, and eastern red-cedar extensively hybridizes with Rocky Mountain juniper over much of the Nebraska Panhandle (Kaul, Sutherland and Rolfsmeier, 2006). The western and arid-adapted limber pine (Pinus flexilis) barely crosses over into Nebraska's Kimball County from Wyoming.

Although irrigation in the North Platte and South Platte valleys extends back for more than a century the development of center-pivot irrigation technology during the 1950s allowed for the irrigation of even fairly hilly ground feasible. This advance resulted in a profusion of center-pivots by the late 1970s, especially in the central and western parts of Nebraska. To understand the impact of irrigation on the current state of the Platte River and its wetlands, a review of some fairly recent history is needed. Nebraska's Natural Resources Districts (NRDs) were established in 1969 by the state legislature in a belated and half-hearted attempt to try manage the state's groundwater resources. These multi-county districts were sensibly organized along watershed boundaries. However, it wasn't until 1975 that they were given authority to regulate groundwater use through the state's Groundwater Management Act, by controlling well-spacing, establishing pumping limits, and proposing controlled-use areas.

By 1982 the NRDs were also charged with establishing groundwater management areas without state-level approval. They could thereby place limits on further local water extractions by declaring their districts to be fully appropriated, or even over-appropriated. Many NRDs delayed for as many years as possible in fulfilling these responsibilities, as their boards were usually dominated by irrigators, and as such the boards were extremely loath to put controls on their own highly profitable activities.

A 1984 legislative bill (LB 1106) helped set the stage for issuing a surface water permit to protect Nebraska's instream flows for fish, wildlife or recreation. However, this change did nothing to protect existing surface water rights from the adverse effects of excessive groundwater pumping. In 1991 a group of irrigators formed "Nebraskans First," an organization dedicated to limiting Nebraska's groundwaters for the primary if not exclusive use by irrigators. They quickly managed to weaken or defeat several state legislative bills that would result in pumping restrictions, including one in 1992 that would have given state control over pumping near streams.

In 1994 the state's Supreme Court affirmed the principle that Nebraska's waters are publicly owned by its citizens (the state constitution's " public interest" clause), but by then the majority of Nebraska's groundwater had already been claimed by irrigators. In 1996 state law (LB 108) was passed that finally acknowledged for the first time the hydrologic connection between surface water and groundwater. At that time the regional NRDs were given authority to terminate local well-drilling at times of drought or when water tables are falling, but they could establish such a a groundwater-use moratorium only after all other remedies had proven to be ineffective.

By 1998 a substantial part of the upper and central Platte's surface water had been determined to be fully appropriated, but no such designations had been applied to the region's groundwater. Since more than half of the Platte's downstream flow comes from groundwater sources, this is comparable to installing fire extinguishers and water sprinklers in the upstairs of a building, but leaving the basement furnace untended.

By 1970 there had still been only about 7,000 center-pivots irrigating lands from groundwater sources in Nebraska, but by 2005 there were about 72,000 center pivots in the state, and increase of ten-fold in little more

than three decades. By 2005 there were 7.2 million Nebraska acres being irrigated by groundwater, and another million irrigated by surface water. By then too, Nebraska was leading the nation in irrigated corn acres, and corn had become the most heavily federally subsidized of all U.S. crops. Over 70 percent of Nebraska's 2005 bumper corn crop (12.7 billion bushels) resulted from irrigation, in spite of a regional drought. By 2006, 94.4 percent of our state's groundwater extractions (averaging some 7,420 million gallons per day) were being used for irrigation. This water consumption was performed by 17,000 irrigators, who then represented only about one percent of Nebraska's human population.

Because of the high level of interest by the general public, free-access viewing platforms for watching cranes, geese and other waterbirds have been established beside two Platte River bridges, they are located less than a mile from a major crane roosting site. Thousands of birds are likely to pass over these sites during each dawn and dusk period in early spring. One of these sites, the Central Platte NRD's Alda platform, is located about two miles south of I-80 exit 305. The Platte Valley's ability to produce enormous corn yields is the major reason it attracts hundreds of thousands of cranes each spring. It also brings in tens of thousands of bird-watchers each March. Visits to crane viewing blinds are available at Audubon's Rowe Sanctuary near Gibbon, or the Crane Trust Nature and Visitor Center near Alda.

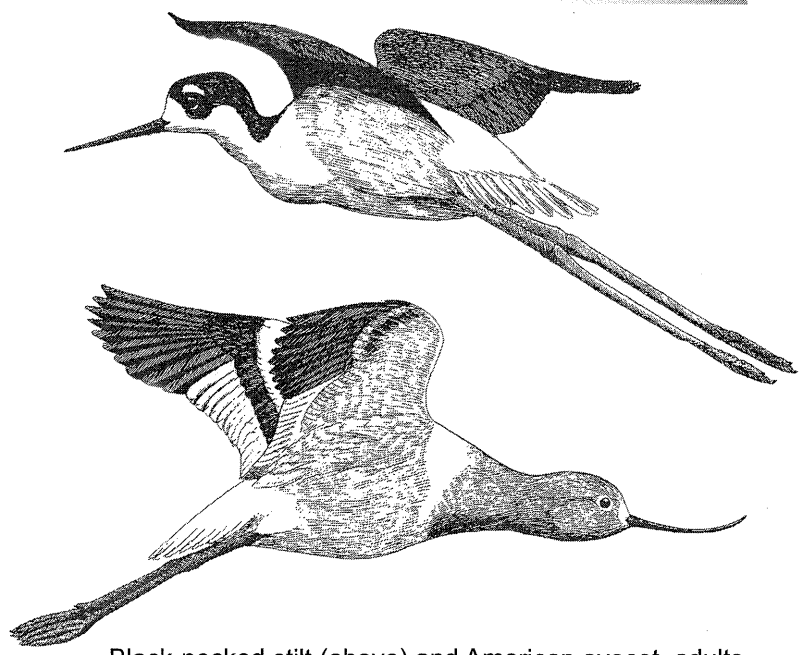
A sample survey of the breeding birds of riparian birds in the Central Platte Valley (Dawson County), based on four years of mist-netting, is shown in **Table 4. Table 5** summarizes a survey of breeding riparian birds, based on point-counts in several locations between Dawson and Hall counties. Finally, as an indication of Platte Valley wetland productivity, some estimates of freshwater aquatic insect taxa present in the wetlands of Hall County are provided in **Table 6.**

Natural History Profiles of some Platte Valley Wetland Species

Sandhill Crane

Three races of sandhill cranes are present in Nebraska, which from small to large are the lesser, the Canadian, and the greater. Of these the lesser is by far the most abundant, possibly comprising about 75–90 percent of the total, while the Canadian and greater might make up the remainder. However, these three geographically distinctive forms overlap in linear measurements,

Fig. 15



Black-necked stilt (above) and American avocet, adults

weights, and other bodily characteristics, making racial identifications difficult if not impossible.

The breeding habitat of the strongly migratory and arctic-breeding lesser sandhill crane consists of low-marshy tundra and, to a lesser extent, brushy muskeg, grass-and sedge-dominated marshes, and even occasionally sandy knolls and dunes. The intermediate Canadian race breeds mostly in muskeg-like wetlands in the boreal coniferous forests of central and sub-arctic Canada. The relatively few greater sandhill cranes that pass through Nebraska are probably headed for breeding wetlands in southeastern Manitoba, southwestern Ontario and northern Minnesota. Since the mid-1990's a few greater sandhill cranes have remained to nest in Nebraska, most often in the Rainwater Basin, reclaiming historic nesting areas that had been abandoned more than a century ago.

The majority of lesser sandhill cranes passing though the central Platte and lower North Platte Valleys during March and early April are headed for tundra breeding grounds in western Alaska and northeastern Siberia. In the wintering areas of Texas and New Mexico the birds concentrate on the grassy and arid Staked Plains, where shallow lakes or rivers provide sandbars and islands for roosting sites. From these roosts the birds fly out daily to forage in newly sprouted wheat or wheat stubble, in alfalfa,

Table 5

Breeding Season Abundance (in descending sequence of abundance estimates) of Riparian Woodland Birds in the Central Platte Valley, Dawson to Hall Counties, 1998–1999.*

House wren 3.85
Baltimore oriole 1.36
American goldfinch 1.22
Blue jay 1.12
Common yellowthroat 1.09
Eastern towhee 0.98
European starling 0.96
Northern cardinal 0.85
American robin 0.78
Gray catbird 0.75
Song sparrow 0.75
Mourning dove. 0.72
Northern flicker 0.72
Warbling vireo 0.57
Brown-headed cowbird 0.57
Black-capped chickadee 0.52
Yellow warbler 0.49
Northern bobwhite 0.37
Red-headed woodpecker 0.34
Brown thrasher 0.33
Cedar waxwing 0.26
White-breasted nuthatch 0.25
Common grackle 0.25
Field sparrow 0.24
Eastern kingbird 0.23
Rose-breasted grosbeak 0.18
Orchard oriole 0.17
Red-winged blackbird 0.17
Great crested flycatcher 0.14
Downy woodpecker 0.13
Eastern wood-pewee 0.09
Wood duck 0.08
Wild turkey 0.08
Red-tailed hawk 0.07
Red-eyed vireo 0.06
Willow flycatcher 0.06
American kestrel 0.02
Yellow-billed cuckoo 0.02
Eastern phoebe 0.02
Bell's vireo 0.02

*List excludes species reported at less than 0.02 individuals encountered/point, and some still-unproven Platte Valley breeding species. Data of Davis (2005).

Table 6

Freshwater Aquatic Insects of the Central Platte Valley Wetlands*

Family	Abundance	Biomass	Average
Chironomidae (Midges)`	3.6	1.0	2.3
Culicidae (Mosquitoes)	1.4	1.4	1.4
Sciomyzidae (Marsh flies)	0.4	2.28	1.34
Muscidae (Typical flies)	0.4	2.0	1.2
Sciardidae (Fungus and root gnats)	1.4	0.84	1.12
Tipulidae (Craneflies)	1.0	1.0	1.0
Limnephilidae (Northern caddisflies)	0.4	0.8	0.6
Ceratopogonidae (Biting midges)	1.2	0.0	0.6
Ephydridae (Shore flies)	0.0	0.6	0.3
Dolichopodidae (Long-legged flies)	0.2	0.0	0.1
Baetidae (Small minnow mayflies)	0.0	0.2	0.1
Leptocercidae (Long-legged caddisflies)	0.0	0.2	0.1

* Based on multiple surveys of five Hall County wet meadows/sloughs ranging from ephemeral to semi-permanent. Index numbers represent means of each family for all five sites, ranking the taxon having greatest abundance/most biomass at each site as "4", and the lowest-ranking taxon as "1", among the four most common families identified. Families are arranged by diminishing overall average index numbers. Data based on Goldowitz and Whiles (1999).

and on such grain crops as sorghum, corn, and barley. Snails, grasshoppers and probably other invertebrates are also eaten whenever they are available, and provide important dietary proteins.

During the spring migration in the Platte Valley of Nebraska the birds forage primarily in wet meadows and corn stubble, eating waste corn, new volunteer corn shoots, and various succulent plants native to the meadows. They roost on the islands and sandbars of the wide and shallow Platte. During the return fall migration migrant flocks concentrate in wheat and cornfields in Canada and the northern states, where they feed on the ripening grain. They then largely over-fly the Platte Valley, which at that time is occupied by a veritable gauntlet of sport hunters often prone to shoot at anything remotely resembling a goose.

While sandhill cranes are in winter flocks, and especially just before the nesting season, they often engage in spectacular "dances." Pairs, and often larger groups of birds, perform a series of vertical bounding movements, with wings partially spread and head bowed. Sometimes cornstalks or other bits of vegetation are flung up during these bouncing dances. The functions of dancing, which is common to all cranes, are still obscure, but it is not restricted to pair formation or the mating season. Cranes also perform the display when disturbed or when nesting birds are threatened. Threat displays toward other cranes involve a stiff-legged strutting toward the opponent, with neck arched, bill pointing downward, and inner secondary feathers raised. Display preening often precedes an actual attack, which includes wing beating, clawing, and bill stabbing.

After sandhill cranes mature, which may require up to four years, they usually remain paired for life. However, death of one of the partners occurs fairly often, so mate-replacement regularly occurs. Additionally, some mate-changing occurs. This usually happens when one bird, typically a female, abandons its mate to pair with another that is holding a seemingly more desirable territory. Once a pair has successfully reared offspring, mate changing is very unlikely to occur.

Established pairs defend the same territory year after year, and may even use the same nest site. The nests are rather simply constructed and vary from an inconspicuous accumulation of grass and twigs in a dry location to a large haystack-like structure built near the edge of a marsh. Both sexes defend the nest and territory, and both take turns at incubation, with the female usually incubating at night.

Incubation of the clutch of two eggs (rarely one or three) begins with the first egg and requires 30 days for hatching. The eggs usually hatch a day apart, and in many cases one of the chicks ("colts") will be tended by each parent. Unless the young are raised separately, antagonism between them often results in the intimidation and starving of the smaller sibling. Thus, most pairs of cranes raise only one offspring per year, but good parents may manage to raise both if they are kept apart while very young. The fledging period for wild birds nesting in central Alaska was 57-63 days over a four-year period, averaging 60 days (George & Christy Happ, personal communication). This duration is about ten days less than the 65-75 days until fledging reported for the larger and more southerly nesting greater sandhill crane. Shortly after fledging of the young the families gather into large flocks, and the long southward migration begins.

It is of interest that all the largest pre-1950's spring assemblages of cranes were seen in the Platte River stretch extending from North Platte to Kearney, rather than occurring between Kearney and Grand Island, where the largest numbers now are concentrated. The river upstream from Kearney is now largely unsuitable for sandhill crane use, owing to heavy vegetational growth and river channel depletion. However, some local river roosting occurs as far upstream as the confluence of the North and South Platte, where cranes wintering as far west as southeastern Arizona are known to stage.

It was not until the sandhill crane was first considered suitable for legal hunting during the late 1950's that the U.S. Fish and Wildlife Service undertook a series of spring aerial surveys that were concentrated along the central Platte Valley. These surveys began in 1959, and from then until 1978 the peak numbers recorded in the mid-continental region ranged from 80,000–225,000 birds, averaging nearly 160,000. Since then the annual maxi-

mum estimates have been progressively higher, generally between 400,000 and 450,000 probably owing in part to more sophisticated and more comprehensive surveys, and also presumably to an actual increase in crane populations. Estimates reached a maximum of about 450,000 sandhills by the early 2000's, with a few in excess of 500,000.

Since 1998 the Platte Valley population estimates have been nearly stable, with an apparent slight upward trend (Johnsgard and Gill, 2011). In recent years the cranes have been showing increasing signs of physiological stress in the Platte Valley during spring. They must now increasingly compete with other species for critical spring food in an era of diminishing waste corn supplies, owing in part to ever more efficient mechanical harvesting techniques. There is also a substantially greater competition for the remaining corn from several million geese and other migratory waterfowl. Our cherished annual spring spectacle of Sandhill Cranes in the Platte Valley may be more precarious than we realize, and must be carefully monitored.

Whooping Crane

Although many Nebraskans have had the indescribable pleasure and joy of watching tens of thousands of sandhill cranes overhead, or even seeing them roosting on Platte River bars and islands during spring migration, only a tiny handful of people can say that they have ever seen whooping cranes in Nebraska. The sheer odds against it are daunting. Compared with 450,000–500,000 sandhill cranes migrating through the state each March, there are now less than 300 whooping cranes in the flock that annually migrates from Aransas National Wildlife Refuge, on Texas's Gulf Coast, to Wood Buffalo National Park, straddling the border of Alberta and Canada's Northwest Territories. Added to this numerical population disparity, whooping cranes migrate somewhat later in spring than the sandhills (during April in Nebraska), after most crane-watchers have gone home. During daytime foraging they also usually frequent rather remote wetlands far from any roads. They generally move in small groups of pairs, family, or extended families that often consist a pair and one or more generations of their offspring.

The lifelong attraction of cranes to many people has meant that we now know as much about the lives of sandhill and whooping cranes as almost any other North American bird. Because the whooping crane was listed as a nationally endangered species in 1972, which created federal funding for research and developing a survival strategy. In 1941 only 22 whooping cranes existed (16 in Texas and six in coastal Louisiana) in the wild. The Louisiana population was extirpated in 1949. It was not until 1954 that the whooping crane's Canadian breeding grounds were discovered, and until 1986 when their world population reached 100 individuals.

It is an ironic fact that, because of the whooping crane's perilous population status, the central Platte River has been protected from destruction through its identification as critical habitat for the species. The early recognition of the Platte's importance to the survival of the whooping crane resulted in the establishment of a habitat mitigation fund associated with the adverse ecological effects of building a large dam on a major Platte tributary (the Grayrocks Dam on the Laramie River) in eastern Wyoming. These funds allowed for the formation in 1978 of the Platte River Whooping Crane Habitat Maintenance Trust (which was recently renamed the Crane Trust).

After the 1970's passage of the Endangered Species Act the central Platte Valley was the first of the areas federally designated as critical habitat for migratory whooping cranes south of Canada. Studies have shown that roosting sites used most often by these cranes during spring migration are more than a half-mile from any human structures or developments. Most crane roosts studied were also more than a third of a mile from the nearest power or phone lines. About half of all the roost sites and two-thirds of the foraging sites had unobstructed visibility for more than a quarter-mile, and were associated with river widths greater than 700 feet. The Platte River vslley historically filled all these criteria.

Visibility and freedom from proximity to human activity are obviously important aspects of whooping crane habitat requirements. They also need access to fairly remote wetlands for both foraging and roosting. Like sandhill cranes,

they prefer to roost in shallow water, well away from heavy shoreline or island vegetation.

The whooping crane's threat of extinction has incidentally helped preserve Platte wetland habitats for many other water-dependent species, including sandhill cranes and three nationally threatened or endangered species. It's endangered status also set the stage for the enactment of the 2006 Platte River Recovery Plan. This plan is a $317 million cooperatively financed program for Platte River wetland preservation and restoration that involves the financial support of the federal government, Colorado, Wyoming and Nebraska. All of the restoration programs are centered in Nebraska, mostly in the central Platte Valley.

Because whooping cranes are federally protected, various accidents are probably the major cause of adult mortality, especially collisions with overhead utility lines by migrating birds. By comparison, sport hunting is the cause of most mortality in sandhill cranes, resulting in the deaths of more than five percent of the lesser sandhill crane population annually. Thankfully, hunting for sandhill cranes in Nebraska has never been allowed, because of the special importance of the Platte to the survival of whooping cranes.

For the biologists who have worked so hard to restore whooping cranes even small miracles such as the gaining of a few chicks per year must be rewarding. At times like these, with ecological disasters becoming ever more common, the thought of seeing immaculate whooping cranes flying high overhead is a comforting one, and remind us that we must all act in such a way as to keep natural treasures such as cranes a living reality.

Least Tern

Market hunters once nearly depleted all of America's least tern populations, mostly because for their attractive white feathers made decorative additions to women's hats. Although the passage of the International Migratory Bird Treaty Act of 1918 largely stopped this frivolity, the coastal populations of least terns were then additionally impacted by development of shorelines for industry, recreation and housing. The interior population was more influenced by river dredging and channelization, dam construction for hydroelectric power generation, water diversion for irrigation and municipal usage and by water pollution. In any case, all least tern populations were seriously affected, and by the 1970s it was determined that the species' population had declined by over 80 percent since the 1940s.

During the Breeding Bird Atlas project (Mollhoff, 2001) the birds were reported breeding along the Missouri River from Dixon to Boyd County. On the Niobrara it extends from its Missouri River confluence west to Brown County, on the Platte from its Missouri River confluence west to Keith County, and on the Loup from its Platte River confluence west to Blaine County. Possible nesting was also reported on the Elkhorn River.

In more recent years most nesting has occurred along the Platte and Missouri rivers, with the Platte population extending west from its mouth to Lake McConaughy and the North and South Platte rivers in Keith County. The Missouri River population extends from Boyd County downstream to Dixon County. There have also been breeding birds along the Elkhorn River from Madison to Cuming County, and along the Loup River from Sherman County east to its Platte River confluence, as well as on the North Loup in Valley County (Panella, 2010). Many of these birds are nesting at sand and gravel mining operations, lakeshore housing developments and dredging operations as their natural nesting habitat (midstream river sandbars) is disappearing.

The diet of least terns varies greatly geographically, but they tend to consume almost any small surface-swimming and non-spiny fish. When feeding young, the size of prey taken depends on the age of the chick being fed. Chicks are fed fish that are equal to or shorter than their beaks, as their beaks grow longer they are able to swallow larger fish. In the central Platte Valley their primary prey are red shiner, creek chub and Plains killifish (Wilson et al., 1993; Thompson et al., 1997). In the lower Platte River, terns feed primarily on larval gizzard shad but also are known to eat red shiners, emerald shiners, and larval largemouth bass. During the courtship ritual, male terns often present the female with a male red shiner--male shiners are more brightly

colored than females (Mary B. Brown, pers. comm.).

In Nebraska, the unvegetated sandbars and sandy islands that once were a typical part of the Platte River scene have largely disappeared, as river flows have declined and annual flow fluctuations have diminished. Thus nesting habitats for this sand-nesting tern have progressively disappeared. But, coincidentally, sand and gravel mining operations and lakeshore housing developments located along the Platte Valley have produced hundreds of small wetlands and lakes, and the barren spoil piles around them attract nesting least terns. These small sandpit lakes support substantial fish populations, so terns are able to hunt there. These lakes are usually quite close to rivers so the birds are easily able to fly to the river to supplement their daily fishing excursions.

Nest sites are selected on bare sand with the birds associating in a colonial manner because of their limited site-selection opportunities. Most local breeding populations of interior least terns are small, of 5–20 nests, and rarely exceed 50 (Thompson et al., 1997); aggregations of 75+ nests have been found in the lower Platte River (Mary B. Brown, pers. comm.). Both sexes help incubate the two- or three-egg clutch over the 21-day incubation period, and both sexes collect food for the developing chicks over the three-week fledging period.

Least terns nest in a high-risk environment, often losing their nests to flooding, human disturbance, or mammalian or avian predators, including feral dogs and cats. But they are persistent re-nesters, sometimes making as many as three nesting attempts in a season. Increasing protection of nesting areas of the least tern have begun to show positive effects and it seems that the species is recovering slowly in Nebraska.

The species' annual reproductive productivity varies greatly from year to year, but between 1987 and 1990 production averaged 0.47 fledgling per pair along the lower Platte River, a figure comparable to that typical of the entire interior population during 1982–1992 (Wilson et al.,1997). Studies on 247 nests found at off-river nesting sites in the lower Platte River by Mary Brown and Joel Jorgensen (2010) indicated that nests placed within lakeside housing developments had a hatching success rate of 72.4 percent. Those placed at sand and gravel pits had a somewhat lower success rate of 51.2 percent. The fledging rate (number of independent tern chicks raised per nest) in the lower Platte River ranged from 0.49 to 1.15 from 2008 to 2010. In 2006 the Platte Valley accounted for 4.4 percent of the Interior race's population, and 7.4 percent of its total colonies (C. A. Lott, via M. B. Brown).

A recovery plan for this population of the least tern was published in 1990 (U. S. Fish & Wildlife Service, 1990), and a five-year review of its recovery status is expected to be published in 2012, followed soon after by a revised recovery plan. With luck and persistence, the interior least tern can eventually be removed from the list of Nebraska's endangered species.

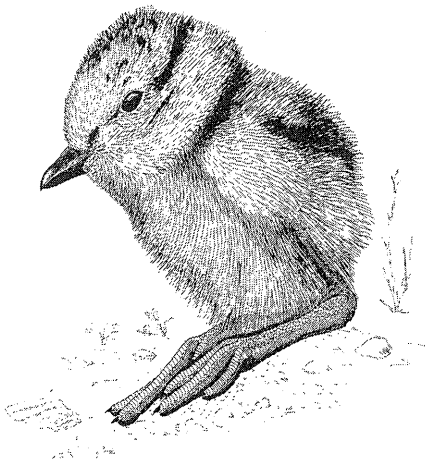
Piping Plover

In many ways the piping plover's story resembles that of the least tern; both species need barren sandy areas near water for nesting, and both have suffered similar population declines as a result of habitat alterations that are mostly the result of human activities. The interior breeding range of this species encompasses the drainage of the upper Missouri River and a few isolated outliers.

The piping plover's breeding range once included all the larger rivers of Nebraska, including especially the Platte and Missouri plus parts of the Niobrara, Elkhorn and Loup. Its current range includes the lower Platte, central Platte, Crescent Lake National Wildlife Refuge, the Loup and Middle Loup, and the lower Niobrara. It also breeds along the sandy edges of Lake McConaughy, where I have observed it nesting since the latter 1970's. During the drought years of the 1990's vast expanses of sandy beaches developed around the lake, providing perfect nesting habitat.

After first finding nesting birds near Kingsley Dam in 1977, I prepared and erected some signs indicating that this was a plover nesting site and that vehicles should avoid it. It was not long until the signs were run over. The birds neverthless continued to nest near a parking areas of Arthur Bay and Martin Bay, and it was frightening to watch tiny,

Fig. 12



Piping plover, chick

newly-hatched plovers running for their lives in trying to escape cars, motorbikes, and ATVs. Later, the local irrigation district erected more signs and wire fences around nest sites, and required monitoring of the nests is now underway. The birds are now nesting on beaches along both the north and south sides of the lake for nearly its entire length. In recent years Lake McConaughy has had the second-largest nesting population of piping plovers anywhere; only South Dakota's Lake Oahe has greater numbers of nests. With the higher reservoir levels of the past few years there will be far less nesting habitat, and the birds are likely to disperse to other sites.

After arriving from coastal wintering areas, males begin advertising territories by flying over them with deep wingbeats and an alternate tilting of the body from side to side, resulting in a fluttering flight. Pair-bonding occurs rapidly, within a few days of arrival. Males perform a nest-scraping display prior to copulation, by calling while kicking sand backwards. This action produces a shallow depression in the sand that might eventually become a nest site. Just before copulation the male walks deliberately toward the female, standing increasingly erect and, with an expanded breast and broadened breast band. With high—stepping movements the male performs a rapid goose-stepping display before mounting (Haig, 1992).

The birds often nest very close to the water's edge, and the color of the adult's back closely matches the color of dry sand. The eggs also perfectly match the color of sand and gravel, and the birds often place their nests where egg-sized pebbles are nearby. The nest is always lined with flat, light-colored pebbles about one-quarter inch in size, which probably help with drainage and keep the eggs dry after rain. Additionally, the soil below has some defined structure, in that the sand substrate is typically stratified, which might also help with drainage and in keeping the eggs dry. There is typically also some driftwood near the nest that serves a windbreak and prevents the nest from being filled with sand. It might also provide a landmark in helping the adults locate their nest. There also often are some annual weeds near the nest, which the chicks use for shade on sunny days (Mary B. Brown, pers. comm.). The newly hatched chicks are just as cryptic, and tend to crouch motionless when danger appraches. They then sprint away at the last possible moment, their tiny legs carrying them over the sand at a remarkable rate.

The species was first listed as endangered in the Great Lakes region, and as threatened on the Atlantic Coast and the northern Great Plains. The U. S. Fish & Wildlife Service's five-year national recovery plan was completed in 2009, and was being updated by 2011. Based on the 2009 data, the Nebraska breeding population then consisted of about 140 pairs on the entire Platte River, about 100 pairs on the Missouri River, 25 pairs on the Niobrara River, and about ten pairs on the entire Loup River system. The three-year running average for breeding success by Nebraska plovers was 1.24 chicks fledged per nest. The Great Plains recovery plan calls for 465 pairs to be present and maintained for 15 years in Nebraska.

THE CENTRAL PLATTE VALLEY WETLANDS

BUFFALO COUNTY

Buffalo County is a Platte–Loup River valley county, with 4,400 acres of surface water. The county's area is 968 square miles (averaging 45.0 people per square mile). It contains five state recreation areas, five wildlife management areas, and its southern border is bounded by the Platte River.

Bassway Strip WMA. Area 725 acres. Includes 90 acres of lakes and sandpits, four ponds and seven miles of Platte River frontage, as well as extensive riparian forest. Extends from 2–9 miles west of I-80 exit 285, along south side of highway. Take 1-80 exit 279 south on U.S. Highway 10, then drive east on marked access road. Lat./Long. 40.68616/-98.94346. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=196

Blue Hole WMA. Area 530 acres. A 30-acre pond and two miles of Platte River frontage, mostly riparian woods. Located two miles south of Elm Creek. Lat./Long. 40.68291/-99.32657.

Rowe Sanctuary and Iain Nicolson Audubon Center. Area ca. 2,000 acres. Nearly six miles of Platte River frontage, including many wet meadows heavily used by sandhill cranes for foraging. Sandy bars and islands are used in March and April by roosting cranes, and in May by nesting least terns and piping plovers. Located two miles south and about two miles west of I-80 exit 285, on Elm Island Road. Open year-around. Admission free, donation requested. Address: 44450 Elm Island Rd., Gibbon, NE. 68840 (Ph. 308/468-5282, E-mail: rowe@nctc.net). URL: http://www.rowesanctuary.org/about%20us.htm

COLFAX COUNTY

Colfax County is a Platte River valley county, with about 1,300 acres of surface water. The county's area is 413 square miles (averaging 25.4 people per square mile). It contains one wildlife management area, and its southern border is bounded by the Platte River.

Whitetail WMA. Area 216 acres. Includes about 90 acres of Platte River riparian forest. Located two miles south and one mile west of Schuyler. Lat./Long. 41.40429/-97.08393.

DAWSON COUNTY

Dawson County is a Platte River valley county, with about 8,000 acres of surface water. The county's area is 1,013 square miles (averaging 24.3 people per square mile). It contains one state recreation area, 11 wildlife management areas, and its entire east-west width is crossed by the Platte River.

Bittern's Call WMA. Area 80 acres. Mixed upland and marshy wetland habitat. Located about ten miles north of Lexington on Highway 21. Lat./Long. 40.84145/-99.84629.

Cozad WMA. Area 182 acres upland, 16 acres wetland, and 0.5 mile of Platte River frontage. Located one mile south and one mile east of Cozad. Lat./Long. 40.83674/-99.98128.

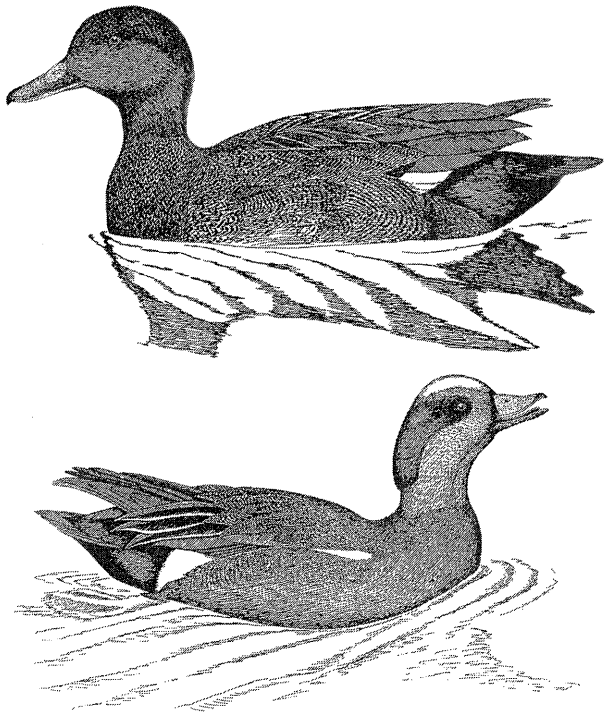
Darr Strip WMA. Area 976 acres, including 770 acres of riparian lowlands and 2.5 miles of Platte River frontage. Located one mile south of Darr. Lat./Long. 40.80952/-99.89854.

Dogwood WMA. Area 402 acres, including a ten-acre lake and 1.5 mile of Platte River frontage. Located four miles west and three miles south of Overton. Lat./Long. 40.69897/-99.62684.

East Willow Island WMA. Area 37 acres, including a 21-acre wetland and 0.3 mile of Platte River frontage and riparian woods. Located three miles west and one mile south of Cozad. Lat./Long. 40.8627/-100.03634.

Johnson Lake SRA. Area 2,229 acres, including a 2,060-acre reservoir. Located seven miles south of Lexington on U.S. Highway 283, immediately south of the Dawson–Gosper County line. State park entry permit required (Ph. 308/785-2685). Lat./Long. 40.68463/-99.82957. A free-access bald eagle viewing facility is nearby at the J-2 Hydroplant, and is open for limited hours during winter months. Drive south from Lexington on U.S. 283, then follow signs for about six miles. The hydroplant is owned by Central

Fig. 13



Gadwall (above) and American wigeon, adult males

Nebraska Public Power and Irrigation District (Ph. 308/324-2811 or 308/995-8601 for information on eagle-viewing). URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=94

West Cozad WMA. Area ca 50 acres, including a 29-acre borrow-pit lake, and some Platte River frontage. Located two miles west and one mile south of Cozad Lat./Long. 40.68463/-99.82957.

Willow Island WMA. Area ca. 80- acres, including a 35-acre borrow-pit lake and riparian woods with some Platte River frontage. Located five miles west of Cozad. Lat./Long. 40.87635/-100.06319.

HALL COUNTY

Hall County is a Platte River valley county bordering the northern edge of the Rainwater Basin, with nearly 2,000 acres of surface water. The county's area is 546 square miles (averaging 102 people per square mile). Hall County contains two state recreation areas, three wildlife management areas, and its entire east-west width is crossed by the Platte River.

Hannon WPA. Area 659 acres. Wet meadows (105 acres) and grassy uplands. Located one mile east and two miles north of the I-80 Shelton Exit 292. Lat./Long. 40.752/-98.697.

Loch Linda WMA. Area 38 acres. A 29-acre cattail marsh surrounded by pasture and riparian forest along the Platte River. From Alda I-80 exit 305, drive one mile north, two miles east, a mile south over Interstate 80 and again two miles east. Lat./Long. 40.81501/-8.42541.

Martin's Reach WMA. Area 89 acres, including 0.7 mile of wooded river frontage of the Platte River, and an oxbow slough. Drive 0.5 mile south off Wood River I-80 exit 300, then three miles west. Lat./Long. 40.7358/-98.6405.

Mormon Island Crane Meadows. Area ca. 2,500 acres. Sedge meadows and tallgrass prairie, bounded by two channels of the Platte River. The largest remaining native wet meadow in the central Platte Valley; as of 1989, 212 bird species had been reported here. Located one mile south of I-80 exit 312 on U.S. Highway 281 then west on Elm Island Road. Managed in part by The Crane Trust. Access is restricted during the crane migration season; don't stray from the road, which dead-ends in about a mile. At other times walking access to the meadows is allowed only with the Crane Trust's permission (308/384-4633)

Mormon Island SRA. Area 152 acres. Includes three large borrow-pit lakes (92 acres) and surrounding parkland. Located 0.25 mile north of I-80 exit 312 at Grand Island. State park entry permit required (Ph. 308/305-6211). Lat./Long. 40.82461/-98.37077. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=123

Crane Trust Nature and Visitor Center (previously known as Nebraska Nature Center). Area ca. 30 acres. This interpretive center provides hiking access to a branch channel of the Platte River, native low prairie meadows, and riparian woods, and blind excursions during the main crane migration season (early March to early April). Hiking trails may be closed during spring crane migration. Over 200 species of birds have been seen here. Located at south end of I-80 Exit 305. Open year-around. 9325 S. Alda Road, Wood River, NE 68883 (Ph. 308/382-1820). URL: http://www.nebraskanature.org.

The Crane Trust (Previously known as The Platte River Whooping Crane Maintenance Trust). The wet meadows and marshland

visible here are rich in wetland birds, but are research areas and mostly off-limits to the public. Drive about two miles south on Alda Road from I-80 Exit 305, turning east on Sandhill Crane Drive, then continue east about one mile on Whooping Crane Drive to Trust headquarters. Address: 6611 W. Whooping Crane Drive, Wood River, NE 68883-9554 (Ph. 308/384-4633).

LINCOLN COUNTY

(see also North Platte Valley Wetlands below)

Lincoln County is a Platte–North Platte valley, Sandhills and southwest playa county, with nearly 10,000 acres of surface water. The county's area is 2,564 square miles (averaging 13.7 people per square mile). About 1,000 sandhill cranes stage here each spring, their westernmost major Platte River staging area. Lincoln County contains two state recreation areas, 11 wildlife management areas, and its entire east-west width is crossed by the Platte River.

Buffalo Bill's Ranch State Historic Park and SRA. Area of park 25 acres; combined Park and SRA. area 233 acres. The park is an historic W. F. Cody ranch property along the south side of the North Platte River, largely managed for tourists, but the SRA. has about 0.5 mile of North Platte frontage. From the city of North Platte take U.S. Highway 83 north to U.S. Highway 30, then go west two miles and north one mile. Park permit required (Ph. 308/535-8025). Lat./Long. 41.16219/-100.79494.

Chester Island WMA. Area 69 acres, including 0.3 mile of Platte River frontage. Drive one mile south and two miles west of I-80 exit 199. Lat./Long. 40.99075/-100.39137.

Lake Malony SRA. Area ca. 1,100 acres, including a 1,000-acre reservoir. Little wetland; largely managed for tourists and campers. Located six miles south of North Platte on U.S. Highway 83. State park entry permit required (Ph. 308/535-8025). Lat./Long. 41.04836/-100.79953. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=112

Platte WMA. Area 242 acres. Mostly riparian woods, upland, and 0.5 mile of Platte River frontage. Located six miles east of Maxwell. Lat./Long. 41.09862/-100.65424.

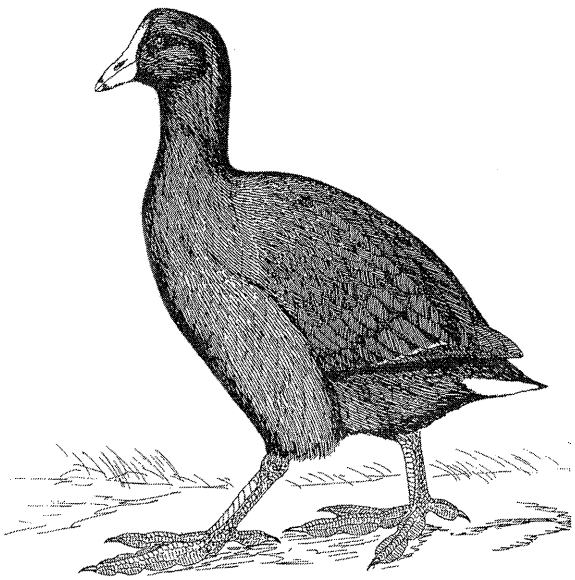
Sutherland Reservoir SRA. Area 3,057 acres, including a 3,020-acre reservoir. Limited wetlands, but some wooded habitats are present along the reservoir shoreline. Located two miles south of Sutherland on State Highway 25. State park entry permit required (Ph. 308/535-8025). Lat./Long. 41.10646/-101.13099. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=171

MERRICK COUNTY

Merrick County is a Platte River valley county, with about 600 acres of surface water. The county's area is 485 square miles (averaging 16.7 people per square mile). There are no state recreation areas or wildlife management areas. Its entire east-west width is bounded on the south by the Platte River.

Bader Memorial Park and Natural Area. Area ca. 200 acres, of which 80 acres comprise the Natural Area. Includes Platte River floodplain woods, sandpit wetlands and native prairie. The local faunal lists have at least 100 species of birds, 29 mammals, 29 fish, 8 reptiles, and 5 amphibians. The surrounding central Platte River valley's plant list includes more than 200 species. The park's riparian woodlands support nesting habitat for the American woodcock and wood duck. Heavily vegetatedsandbars are used by the black-billed cuckoo, Bell's vireo, common yellowthroat, yellow warbler and red-winged blackbird. Barren sandbars provide nesting for the least tern, piping plover, killdeer and spotted sandpiper (Whitney & Whitney, 1987). Located three miles south of Chapman. Owned by Bader County Park Board. For information, contact the Prairie Plains Resource Institute, 1307 L St., Aurora, NE 68818 (Ph. 402/694-5535).

Fig. 16



American coot, adult

THE NORTH PLATTE VALLEY WETLANDS

The North Platte River enters western Nebraska after having passed through several major Wyoming impoundments (Seminoe, Pathfinder, Alcova, Glendo and Guernsey). It has its origins in the mountains of northern Colorado and southern Wyoming. In Nebraska it is impounded again, by Kingsley Dam, producing Nebraska's largest reservoir. As a result, annual and seasonal water flows of the North Platte are markedly affected by human controls, especially insofar as they are regulated by irrigation practices. In addition to such water diversions for irrigation, local well-drilling and drainage activities in western Nebraska's North Platte Valley have had the sad result that that very few natural wetlands still remain within that valley.

A relative-abundance sample of the birds of the North Platte valley, as measured by the numbers mist-netted at Cedar Point Biological Station (Keith County) over a seven-year period, are summarized in **Table 8**. Of course, mist-netting is a selective sampling method, and primarily captures smaller land birds. A summary of wetland plants observed in Garden, Morrill and Scotts Bluff counties, is shown in **Table 9**.

GARDEN COUNTY

(see also Sandhills Wetland Region, Chap 6)

Garden County is a Sandhills and North Platte valley county, with over 22,000 acres of surface water, much of which is somewhat to highly alkaline. The county's area is 1705 square miles (averaging 1.2 people per square mile). Crescent Lake National Wildlife Refuge, the most important wetland are in the western Sandhills, is located in Garden County (see Alkaline Wetlands Region for Sandhills wetland sites). Garden County contains one national wildlife refuge, one state recreation area, and its entire east-west width is crossed by the Platte River.

Clear Creek WMA. Area 6,195 acres. Consists of Clear Creek Wildlife Refuge (2,500 acres), and a controlled waterfowl hunting area (3,744 acres). Includes the marsh-like western end of Lake McConaughy and the North Platte inflow area, extending west into Garden County. There it connects with the Garden County Game Preserve, a riparian wetland habitat and waterfowl refuge. It is one of the westernmost major spring staging areas for Alaska- and Canada-bound sandhill cranes in Nebraska (Siberia-bound birds stage still farther west, near North Platte). The site's extensive wet meadows support nesting bobolinks, swamp sparrows, and dickcissels, The western grebe and much rarer Clark's grebe have nested at Clear Creek, as have cattle egrets. Least bitterns have been seen during the breeding season, as has the even rarer king rail. Located about five miles east of Lewellen, south of State Highway 92. Lat./Long. 41.29125/-102.02603.

KEITH COUNTY

Keith County is a Sandhills and North Platte-South Platte valley county, with over 37,000 acres of surface water, mostly consisting of reservoir acreage. The county's area is 1,061 square miles (averaging 7.7 people per square mile). Kingsley Dam is the largest dam in Nebraska, and Lake McConaughy is the state's largest and deepest reservoir.

Fig. 14

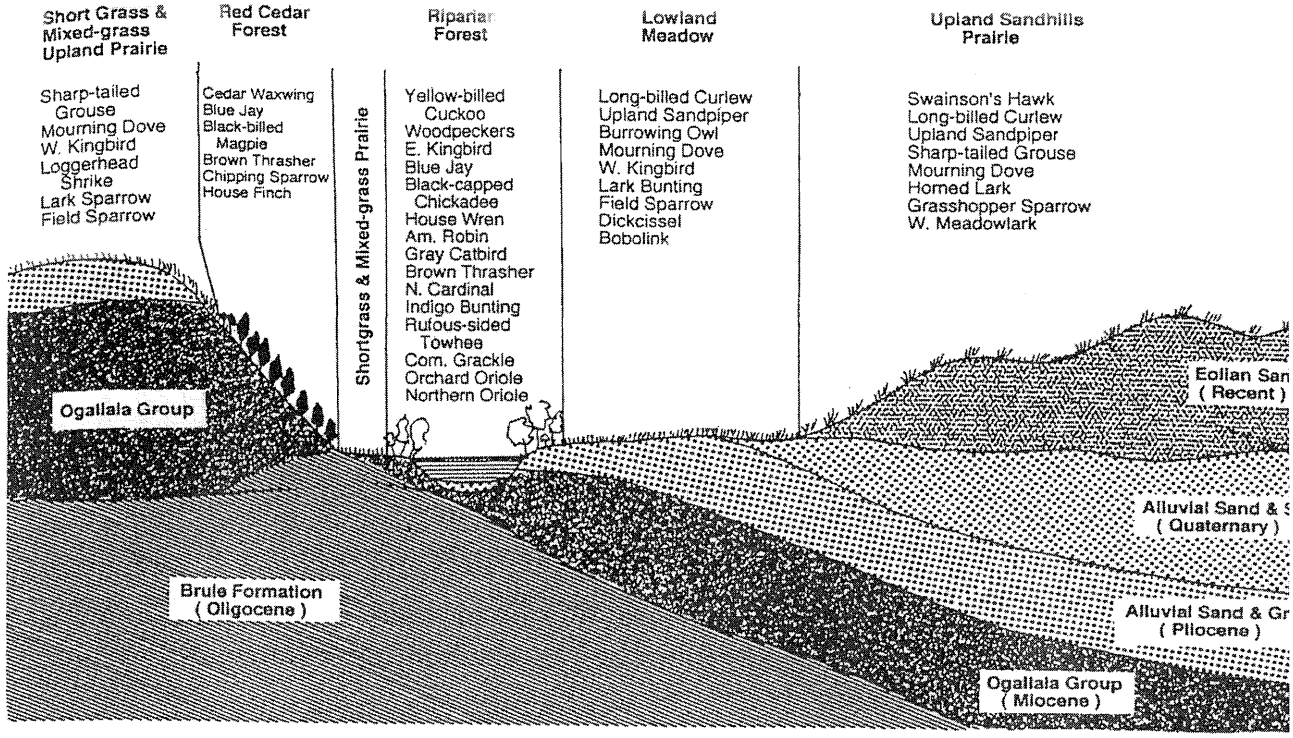


Fig. 14. Cross-section view of typical North Platte Valley habitats and some associated breeding birds. After Johnsgard (1995).

To the south the reservoir is bounded by typical Sandhills dunes, and to the north by eroded high plains and irrigated agricultural lands. The South Platte River is typically a near-dry channel here, owing to heavy irrigation withdrawals in Colorado and more western part of Nebraska. Keith County contains 14 state recreation areas, one wildlife management area, and its entire east-west width is crossed by the Platte and South Platte rivers.

Lake McConaughy SRA. Area 41,192 acres. This large reservoir (over 30,000 acres), was developed for flood control, irrigation and recreational use. It is about 22 miles long, 3 miles wide, up to 142 feet deep, and has 105 miles of shoreline when full. Including Lake Ogallala SRA, the site totals about 5,500 land acres. Mostly bare sandy shorelines are on northern side, but extensive wetlands exist at see Clear Creek WMA, at the lake's western end (see Garden County account above). A bird list for the Lake McConaughy region has 342 species (Brown and Brown, 2001), and more recent observations have increased the total number of species to about 370 (Mary Brown). This total is by far the largest local species list for any wetland area in the state, and probably is the largest for any site in the Great Plains. A high percentage of the area's bird species are wetland-dependent species. The lake is an important nesting area for both the nationally threatened piping plover and endangered interior least tern. Western and Clark's grebes summer and have bred, and the lake also hosts many nonbreeding double-crested cormorants and American white pelicans throughout summer. Large numbers of waterfowl, gulls, other water birds and bald eagles winter here. Located nine miles north of Ogallala on State Highway 61. State park entry permit required (Ph. 308/284-8800). Lat./Long. 41.24813/-101.8258. URL: http://www.lakemcconaughy.com/ngp.html

Lake Ogallala SRA. Area 659 acres. Lake Ogallala (320 acres) is maintained by spillway

Fig. 17

Yellow-headed blackbird, adult male

water from Lake McConaughy, and thus has large daily and seasonal water fluctuations. Limited wetland areas exist along the northern shoreline, and the lake supports good number of coots, white pelicans, double-crested cormorants and other mostly non-breeding waterbirds. Ospreys have recently attempted to nest on specially erected platforms near the diversion dam. Located nine miles north of Ogallala on State Highway 61. A free-admission bald eagle viewing center below Kingsley Dam is open from late December to early February (308/284-2332). State park entry permit required (Ph. 308/284-8800). Lat./Long. 41.22366/-101.66264.

Ogallala Strip WMA. Area 453 acres. Includes 2.5 miles of the South Platte River frontage, consisting of scrubby riparian woods and sandy bottomlands along the nearly dry river channel. Located one mile south and three miles west of Ogallala. Lat./Long 41.109/-101.766.

LINCOLN COUNTY

(see also Central Platte Valley Wetlands above)

Lincoln County is a Platte–North Platte River valley and Sandhills county, with nearly 10,000 acres of surface water. The county's area is 2,564 square miles (averaging 13.7 people per square mile). About 1,000 sandhill cranes stage near the junction of the Platte and North Platte rivers each spring in the vicinity of Hershey. Lincoln County contains two state recreation areas, 13 wildlife management areas, and its entire east-west width is crossed by the Platte and South Platte rivers.

Muskrat Run WMA. Area 224 acres. Mostly riparian woods along the North Platte, including 0.5 mile of creekbottom frontage, and marshy areas. Located six miles east and one mile north of Hershey. Lat./Long. 41.19618/-100.89433.

North River WMA. Area 681 acres. Riparian woods along the North Platte, with two miles of river frontage. There is a spring sandhill crane roost at the southeast edge of the site, about 0.75 mile from the north parking lot. Located three miles north of Hershey. Lat./Long. 41.20194/-100.98341.

SCOTTS BLUFF COUNTY

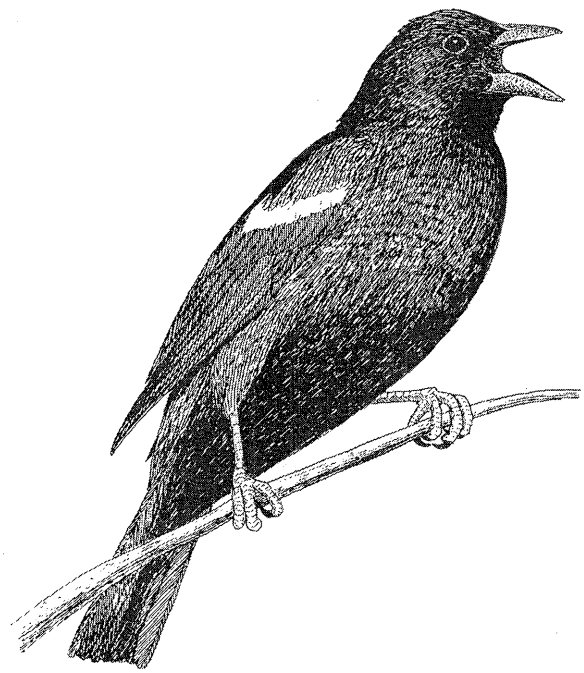
Scotts Bluff County is a North Platte River valley county, with about 3,000 acres of surface water. The county's area is 739 square miles (averaging 48 people per square mile). It contains one national wildlife refuge, two state recreation areas, three wildlife management areas, and its entire east-west width is crossed by the North Platte River.

Kiowa WMA. Area 540 acres. A small alkaline wetland (one of few remaining natural wetlands in the North Platte Valley) with a surrounding marsh, emergent vegetation, and grasses. Freshwater springs feed the marsh, and the main pool is controlled by a dike. At least 70 bird species have been seen here, primarily shorebirds, wading birds and waterfowl. Nesting wetland birds include cinnamon teal, American avocet, black-necked stilt, Wilson's phalarope, Wilson's snipe and

great-tailed grackle. The Virginia rail and sora are common and possible nesters, as is the northern harrier. Jon Farrar (2004) listed 35 birds as a "sampler" of the area's bird life, of which 30 are typical wetland species. Located two miles south of Morrill. Lat./Long. 41.92198/-103.93851.

North Platte National Wildlife Refuge. Area 5,047 acres. Includes Lake Alice (1,377 acres when full), Lake Minatare (430 acres) and Winters Creek (700-acre). Stateline Island (135 acres, 0.7 mile south of Henry on State Highway 86) has a nature trail along the North Platte River along the north side and is bounded by Centennial Creek on the south side. The major wetland in this subdivided refuge is the Winters Creek Unit, a shallow impoundment of Winters Creek. Over 300 acres of cottonwood and ash forest are present beside the lakes. The total refuge bird list consists of 228 species, including 58 known or probable breeders. Wetland birds include 28 species of waterfowl, 28 shorebirds, 12 gulls and terns, 8 wading birds and 6 grebes. Jon Farrar (2004) listed 69 birds as a "sampler" of the refuge's bird life, of which 43 are typical wetland species. In recent years bald eagles have nested, and ospreys have unsuccessfully attempted to nest. Located four miles north and eight miles east of Scottsbluff (Ph. 308/635-7851). URL: http://crescentlake.fws.gov/northplatte/

Fig. 18



Red-winged blackbird, adult male

Table 7

Breeding Wetland and Woodland Birds of the Lower North Platte and Central Platte River Valleys*

Wetland, Shoreline & Wet Meadow Species

Canada goose (NP) 250
Wood duck (NP) 128
Gadwall 1,063
American wigeon 530
Mallard (NP) 5,743
Blue-winged teal (NP) 5,730
Northern shoveler 655
Northern pintail 2,600
Green-winged teal 162
Redhead 25
Ruddy duck (NP)
Pied-billed grebe (NP) 485
Horned grebe
Eared grebe
Western grebe (NP) 250
Clark's grebe (NP)
Double-crested cormorant (NP) 200
American bittern (NP)
Least bittern
Great blue heron (NP) 280
Cattle egret (NP)
Green heron (NP) 1,082
Black-crowned night-heron (NP)
Bald eagle (NP)
Northern harrier (NP) 100
Virginia rail (NP)
Sora (NP) 1,080
Common moorhen
American coot (NP) 3,254
Snowy plover (NP)
Piping plover (NP) 119
Killdeer (NP) 19,500
Black-necked stilt (NP)
American avocet 75
Willet
Spotted sandpiper 830
Upland sandpiper (NP) 59,000
Long-billed curlew (NP) 5,145
Wilson's snipe 50
American woodcock
Wilson's phalarope (NP) 2,000
Least tern (NP) 65–80
Black tern
Short-eared owl
Belted kingfisher (NP) 65
Bell's vireo (NP) 7,000
N. rough-winged swallow (NP) 2,000
Bank swallow (NP) 2,685
Barn swallow (NP) 72,330
Cliff swallow (NP) 20,000
Sedge wren 125
Marsh wren (NP) 3,395
Common yellowthroat (NP) 16,500
Yellow-breasted chat (NP)
Savannah sparrow 1,290
Song sparrow (NP) 1,085
Swamp sparrow (NP) 1,080
Bobolink (NP) 43,500
Red-winged blackbird (NP) 148,000
Yellow-headed blackbird 3,740
Great-tailed grackle (NP) 250
Eastern meadowlark (NP)

Table 7, cont.

Riparian & Upland Woodland Species

Northern bobwhite (NP) 10,500 (FE)
Wild turkey (NP) 200 (FE)
Mississippi kite (NP) (OF–FE)
Broad-winged hawk (CF–OF)
Red-tailed hawk (NP) (OF)
American kestrel (NP) 2,945 (FE)
Swainson's hawk (NP) 250 (FE)
Mourning dove (NP) 180,000 (FE)
Black-billed cuckoo (NP?) 100 (FE)
Yellow-billed cuckoo (NP) 500 (FE)
Eastern screech-owl (NP?) (OF)
Great horned owl (NP) 2,500 (OF–FE)
Long-eared owl (NP) (OF)
Whip-poor-will (FE)
Red-headed woodpecker (NP) 29,000 (OF–FE)
Red-bellied woodpecker 90 (CF)
Downy woodpecker (NP) 250 (CF)
Hairy woodpecker (NP) 1,250 (CF)
Northern flicker (NP) 47,000 (OF)
Western wood-pewee (NP) 70 (CF)
Eastern wood-pewee 380 (CF)
Willow flycatcher (NP) 940 (FE)
Eastern phoebe (NP) 55 (FE)
Say's phoebe (NP) 250 (FE)
Great crested flycatcher 650 (CF)
Western kingbird (NP) 98,500 (FE)
Eastern kingbird (NP) 65,000 (FE)
Warbling vireo (NP?) 3,460 (OF)
Red-eyed vireo (NP?) 300 (CF)
Blue jay (NP) 7,000 (OF)
American crow 8,540 (FE)
Tree swallow (NP) 3,655 (OF)
Black-capped chickadee (NP) 3,120 (OF)
White-breasted nuthatch 30(OF)
Bewick's wren 30 (FE) (OF)
House wren (NP) 45,000 (OF)
Blue-gray gnatcatcher (CF–OF)
Eastern bluebird (NP) 100 (FE)
Wood thrush (NP) 50 (FI)
American robin (NP) 120,000 (OF)
Gray catbird (NP) 3,000 (FE)
Northern mockingbird (NP) 30 (FE)
Brown thrasher (NP) 26,000 (FE)
European starling (NP) 85,000 (FE)
Cedar waxwing (NP) 60 (CF)
Yellow warbler (NP) 19,000 (FE)
American redstart 20 (FI)
Ovenbird (NP?) (FI)
Eastern/Spotted towhee (NP) 150 (FE)
Chipping sparrow 5,125 (OF)
Field sparrow (NP) 2,820 (FE)
Scarlet tanager 20 (OF–CF)
Northern cardinal (NP) 5,745 (OF–FE)
Rose-breasted grosbeak (NP) 610 (OF)
Black-headed grosbeak (NP) 5,480 (OF)
Lazuli bunting (NP?) 30 (FE)
Indigo bunting (NP?) 2,500 (OF–FE)
Brewer's blackbird (NP?) 2,335 (FE)
Common grackle (NP) 251,000 (FE)
Brown-headed cowbird (NP) 175,000 (FE)
Orchard oriole (NP) 25,000 (FE)
Baltimore(NP)/Bullock's oriole (NP) 56,000 (FE)
American goldfinch (NP) 19,000 (FE)
House sparrow (FE)

Species of Grassland, Scrub & Other Non-riparian Habitats

Ring-necked pheasant (NP) 16,500
Greater prairie-chicken (NP) 7,718
Sharp-tailed grouse (NP) 2,570
Turkey vulture (NP) 30
Ferruginous hawk (NP) 20
Golden eagle (NP) 25
Prairie falcon (NP) 4
Barn owl (NP)
Burrowing owl (NP) 800
Common nighthawk (NP) 14,500
Common poorwill (NP?)
Rock pigeon (NP) 1,764
Eurasian collared-dove (NP?)
Chimney swift (NP) 95,000
Loggerhead shrike (NP) 135
Black-billed magpie (NP) 2,570
Chihuahuan raven 5
Purple martin (NP) 5,100
Horned lark (NP) 87,500
Rock wren (NP) 9,000
Cassin's sparrow (NP) 2
Brewer's sparrow 250
Vesper sparrow 3,860
Lark sparrow (NP) 51,000
Lark bunting (NP) 103,500
Grasshopper sparrow (NP) 248,500
Blue grosbeak (NP) 700
Dickcissel (NP) 69,500
Western meadowlark (NP) 302,500
House finch (NP) 500
Pine siskin (NP) 10

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*Mainly based on Faanes and Lingle (1995), whose study covered nearly 10,000 square miles (26,000 sq. km.) over 12 counties, from southern Garden County in the lower North Platte Valley east through Merrick County in the lower central Platte Valley. Numbers shown represent their estimates of total nesting pairs in the region, 1979–1980. Using newer information, 11 species shown in italics have been added to Faanes and Lingle's original list of known regional breeding species; three additional underlined species indicate probable but still unproven regional breeders. The species identified with a (NP) have been found nesting within the lower North Platte Valley (southern Garden, Keith and western Lincoln counties), primarily in the vicinity of Cedar Point Biological Station (e.g., Brown & Brown, 2001). Those shown as (NP?) also almost certainly nest in the lower North Platte Valley, judging from indirect evidence such as observations of singing males or adults with brood patches. The species listed as associated with riparian forests are identified as those typical of closed-forest (CF), forest-edge (FE), forest-interior (FI) and open-forest (OF) habitats, these designations largely follow Davis (2005). A few species are shown as breeding in more than one of these forest types, and some also breed in non-forest habitats.

Table 8

Relative Abundance (in descending sequence of captures) of Riparian Birds in the North Platte Valley *

Orchard oriole 1,715		Indigo bunting 43	
Red-winged blackbird 1,074		Lazuli bunting 41	
American goldfinch 906		Yellow-rumped warbler 40	(migrant)
Northern rough-winged swallow 238		Black-headed grosbeak 38	
Yellow warbler 854		Orange-crowned warbler 37	(migrant)
Cliff swallow 648		Northern flicker 36	
House wren 342		Lincoln's sparrow 34	(migrant)
Chipping sparrow 340		Red-eyed vireo 33	
Common yellowthroat 310		Grasshopper sparrow 33	
Lark sparrow 308		Belted kingfisher 31	
Baltimore oriole 280		Barn swallow 33	
Swainson's thrush 259	(migrant)	Blue grosbeak 32	
Black-capped chickadee 259		Dark-eyed junco 28	(migrant)
Yellow-breasted chat 250		Common grackle 27	
American robin 250		Rock wren 27	
Bell's vireo 207		Bank swallow 23	
Clay-colored sparrow 200	(migrant)	Song sparrow 22	
Spotted towhee 182		Red-headed woodpecker 17	
Willow/Alder flycatcher 160		Yellow-headed blackbird 17	
Gray catbird 155		Yellow-billed cuckoo 16	
Field sparrow 154		Hairy woodpecker 15	
Brown-headed cowbird 148		Tree swallow 15	
Brown thrasher 140		European starling 13	
Warbling vireo 110		Marsh wren 10	
White-crowned sparrow 8	(migrant)	American redstart 10	(migrant)
Cedar waxwing 77		McGillivray's warbler 10	(migrant)
Northern cardinal 71		Blackpoll warbler 9	(migrant)
Blue jay 68		Bullock's oriole 9	
Ovenbird 65	(migrant)	Northern waterthrush 7	(migrant)
Downy woodpecker 63		Rose-breasted grosbeak 7	
Dickcissel 60		Western meadowlark 7	
Pine siskin 59	(migrant)	Red crossbill 7 (migrant)	

Mourning warbler 6	(migrant)	White-breasted nuthatch 2	
White-throated sparrow 6	(migrant)	Wood thrush 2	(migrant)
Black-billed cuckoo 5		Chestnut-sided warbler 2	(migrant)
Western wood-pewee 5		Black-throated blue warbler 2	(migrant)
Eastern phoebe 5		Prothonotary warbler 2	(migrant)
Red-breasted nuthatch 5	(migrant)	Blue-winged warbler 2	(migrant)
Black-and-white warbler 5	(migrant)	Scarlet tanager 2	(migrant)
Eastern wood-pewee 4		Eastern towhee 2	
Black-billed magpie 3		Eastern meadowlark 2	
Tennessee warbler 3	(migrant)		
Sharp-shinned hawk 2	(migrant)		
Great crested flycatcher 2			

* Based on 1992–1997 & 2001 Spring and Summer Banding at Cedar Point Biological Station, Keith County. Numbers indicate capture totals; single-capture records are not included. Data of Scharf et al., 2008)

Table 9

Saline Wetland Meadow Vegetation of the North Platte Valley*

Apocynaceae – Dogbane/Milkweed Family

Hemp (Prairie) dogbane. F, M

Asteraceae – Sunflower Family

Annual goldenweed. U, D #
Bull thistle. F, D
Canada goldenrod. C, M
Canada thistle. C, W, M
Dandelion. C, D, M
False salsify. Rare, M #
Flodman thistle. F, M
Hawk's-beard. F, M.
Horseweed. C, D
Musk thistle. C, D
Prairie coneflower. F, M
Prickly lettuce. F, D
Rayless salt-marsh aster. U, W, M #
Western ragweed. C, M

Brassicaceae – Mustard Family

Peppergrass. F, D
Thelypody. U, M #

Caryophyllacee – Honeysuckle Family

Salt marsh sand spurrey. Rare, W #

Cont. Next Page

Table 9, cont.

Chenopodiaceae – Goosefoot Family
Halberd-leaved atriplex. U, M. #
Kochia. C, D
Pitseed goosefoot. F, M
Sea blite. C, S

Cleomaceae – Cleome Family
Rocky Mountain bee plant. F, D

Cyperaceae – Sedge Family
Clustered field sedge. C, M
Common threesquare. C, M
Nevada bulrush. U, S #
Redstem spike-rush. F, W

Fabaceae – Bean Family
Alfalfa, F, D
Black medic. C, D
Strawberry clover. F, M
White sweet clover. F, D
Wild licorice. F, M
Yellow sweet clover. F, M

Gentianaceae – Gentian Family
Prairie gentian. F, M

Iridaceae – Iris Family
Blue-eyed grass. F, M

Juncaginaceae – Arrowgrass Family
Arrowgrass. C, S

Najadaceae – Naiad Family
Alkali naiad. Rare, A #

Onagraceae – Evening Primrose Family
Velvety guara. F, D

Plantaginaceae – Plantain Family
Alkali plantain. F, M, S

Poaceae – Grass Family
Alkali muhly. F, M
Alkali sacatun. C, M, S
Blue grama. F, M
Downy brome, F, D
Foxtail barley. C, M
Inland saltgrass. C, S
Japanese brome. C, D
Plains bluegrass. C, M
Prairie cordgrass. F, W
Prairie wedgegrass, F, W, M
Redtop. F, W, M
Slender wheatgrass. C, M
Smooth brome. F, M
Switchgrass. F, M
Tall wheatgrass. F, M
Western wheatgrass. C, M

Polygonaceae – Buckwheat Family
Bushy (Tall) knotweed. C, S, M

Primulaceae – Primrose Family
Sea-milkwort. Rare, M #
Shooting star. U, M #

Ranunculaceae – Buttercup Family
Shore buttercup. F, W, M

Rosaceae – Rose Familly
Silverweed. R, M

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*After Rolfsmeier (1993), based on surveys of 16 sites in Garden, Morrill and Scotts Bluff counties. Species found in 9–16 sites are identified as "Common" (C). Those recorded in 7–10 sites are identified as "Frequent" (F), and those seen in 3–6 sites are identified as "Uncommon (U). Species reported from fewer than seven sites are excluded from the list unless they were considered element species (indicated by # symbol) that are possibly rare in Nebraska. Plant species are arranged alphabetically within families by vernacular names; see appendices for Latin names. Habitats are identified as A (aquatic), D (disturbed ground, M (meadow, relatively dry, level grassland), S (salt crust, seasonally wet, brackish areas) and W (wet ground such as sloughs and marshes, including freshwater sites).

Chapter 5

Other River Valley Wetlands

Besides the rivers just described, Nebraska is blessed with many other important river systems. Two, the Loup and Elkhorn, are wholly encompassed within the state's borders, and are largely dependent on spring-fed groundwater from the Ogallala aquifer. A third, the Republican, has the sad fate of crossing three states between its headwaters and mouth. The appropriately named Republican River bares the hallmarks of both state-based political chicanery and private greed in terms of it water history and the river's questionable ability to survive as a functioning aquatic ecosystem.

Natural History Profiles of some Typical Riverine Species

Muskrat
(adapted from Johnsgard, 2001)

There are few if any permanent marshes in Nebraska that lack a few haystack-like piles of vegetation scattered about, a sure indication that muskrats are present. Muskrats lack the beaver's trait of dam-building, and their burrowing into human-made impoundments are more likely to cause leaks and damage them than to improve their wetland habitat. But muskrats do regularly cut narrow paths through dense reedbeds, and these passageways are often used by ducks, grebes, and other aquatic animals. Their rounded "houses" of reeds, rushes and cattails also make convenient lookout points, nest sites or loafing places for some of these same species.

Muskrats are less than ten percent as heavy as beavers, the adults weighing about 1.7–3 pounds, with the females averaging heavier than the males. Because of their much smaller body size and more generalized and abundant foods, muskrat populations are far greater than those of beavers. Under very good conditions muskrat breeding densities may at times exceed thirty animals per acre of marsh. However, there are often substantial annual variations in abundance, and at least in northern parts of their range the species may undergo regular cycles of abundance and scarcity.

Muskrats don't have all the adaptations for diving and social living that beavers exhibit, but do have some adaptive similarities related to aquatic life. Their hind feet are partly webbed, and their long tail is somewhat flattened vertically and is used as a rudder. They too can remain under water for long periods, up to about 17 minutes, and unlike the beaver they often supplement their herbivorous diet with various animal materials. Like beavers, the animals produce a musky scent from glands in the anal region. This odor is especially typical of males during the breeding season, and is used to mark territories. Also like beavers, they construct shoreline dens with underwater entrances that are difficult to detect visually. Only where steep banks are unavailable are the above-water "houses" likely to be built. They are usually built of dried cattails, bulrushes and similar herbaceous vegetation during the autumn, and primarily serve as winter retreats.

Muskrats form monogamous pair bonds during the breeding season, and are distinctly territorial. Females kill intruding females, and males will fight with encroaching males. Because of their fairly small size and associated vulnerability, muskrats are favored prey of many predators, especially mink, which often enter their dens and kill them. Otters are another serious aquatic predator. On land, coyotes and raccoons pose survival problems, as do weasels. Larger raptors such as the great horned owl, red-tailed hawk and northern harrier are likewise potential aerial threats. Given all these enemies, average lifespans are rather short, probably about 3-4 years under natural conditions. Sexual maturity occurs the first year, or even as soon as six months after birth. The usual litter is of 6-8 young, and there may be several litters produced per year, depending on the length of the breeding season.

Wilson's Snipe

Like other snipes, Wilson's snipes are rarely seen until they fly, usually flushing from wet meadows,

marshes, or boggy areas, rather than from wooded swamps or alder thickets as is typical of woodcocks. As snipes flush, they utter a raspy scaipe note, and fly off in a low, erratic manner before dropping down into the marshy cover again and disappearing.

The diet of Wilson's snipes throughout the year consists of about 80 percent animal material, primarily insects as well as smaller amounts of crustaceans, earthworms, and mollusks. They also eat seeds like those of sedges, smartweeds, bulrushes, and other marsh plants. Most of their food is obtained by probing in shallow water, but some surface-feeding is also apparently done.

The Wilson's snipe's wintering habitat includes a variety of marsh types—delta and prairie marshes, rice fields, and cattail thickets—all characterized by wet organic soils. A few snipes may winter in Nebraska during mild winters. Marshes are also used during migration, but breeding usually occurs in bogs or low wetland vegetation. Most of the relatively Nebraska breeding records are from the Sandhills region (Mollhoff, 2001).

Even during winter, Wilson's snipes are apparently not especially gregarious, but may concentrate in areas of open water during freezing weather. At times flocks are seen in migration at a fairly high altitude, but they are not nearly so conspicuous as many shorebirds, and probably migrate mainly at night. Shortly after they reach the breeding grounds, the males establish territories and await the arrival of the females 10-14 days later.

The most common male territorial display on the breeding grounds is "bleating," or "winnowing," an aerial performance in which the male (and later also the female) rises some 300 feet into the air, then performs a series of swooping dives at the rate of about eight per minute. In these dives the wings are partially closed and the tail feathers, especially the outer pair, are widely spread. The resulting interruption of airflow from the wings by the vibrating outer feathers produces an eerie tremolo huhuhuhuhuhu sound. Territorial birds also have several vocalizations, including a repeated cut-a-cut "yakking" call, which is usually uttered on both ascent and descent during the aerial display flight, and on the ground as well. Several other ground calls and displays are typical, including a tail-fanning display for distracting intruders' attention from the nest. Wilson's snipes are monogamous, and the male remains with his offspring through the brood-rearing period.

The nest is usually built in wet, marshy ground, especially where low grass clumps or brush rises above the surface of the bog, and is simply a depression in clumps or tussocks, lined with grasses or dead leaves. The clutch size is nearly always four eggs. Incubation, performed entirely by the female, normally lasts 18-19 days. Typically the first two chicks that hatch are attended by the male, while the female cares for the latter two. The parents then raise their respective chicks separately. The chicks are fed by the attending parent, by probing in the mud and allowing the young to take foods as the bill is withdrawn.

Snipe chicks make their first short flights at the age of about 15-18 days. By the time they are about six weeks old they sometimes begin to form groups ("wisps") with others of their own age; such flocks may number in the hundreds. These young birds apparently migrate south in advance of the adults, and it is probable that adult females migrate south somewhat before adult males.

Common Yellowthroat

Common yellowthroats are nearly ubiquitous in Nebraska's wetlands, and probably breed in every county. They are especially common in swampy areas with rank vegetation, but at times may even be found in dry, brushy uplands (Mollhoff, 2001).

River margins and ponds in eastern Nebraska are especially favored breeding habitats. I saw my first male common yellowthroat at the edge of a swampy marsh in Minnesota when about twelve years old, and was so entranced by it that I ignored the poison ivy I was standing in, or the hordes of mosquitoes buzzing about my head.

Like most of Nebraska's other warbler species, yellowthroats arrive in mid-May, and soon every wetland is alive with their animated and syncopated

songs, sounding like wichity, wichity.... Typically this distinctive song is uttered as long phrases (often of about 25 notes) that may be repeated 30 or more times. Most males have only this single-phrase song repertoire as their primary advertising or perch song. Males also utter a flight song, an extended series of short-duration notes that grade into elements of the primary perch song, and end with a complex series of longer notes and phrases. There is some broad-scale geographic variation in phrase complexity, with western birds having greater note and phrase complexity than occur in eastern birds (Guzy and Ritchison, 1999).

In good habitats, territories are relatively small, sometimes being as small as 0.1 hectare (0.24 acre). Territorial sizes vary considerably, depending on the aggressiveness of the individual male, the desirability of the territory, and the density of males in the area. Although usually monogamous throughout a breeding season, cases of polygyny have been reported rarely. Courtship begins when females arrive on breeding areas, often about a week after the males, and after bonding has occurred the males closely attend to their mates. However, females show no special fidelity to their mates, and sometimes copulate with other males. The incidence of such behavior is unknown

The nest is constructed by the female, and is usually well concealed and close to the ground, among grasses, sedges and other herbaceous plants. In marshy areas where water might inundate nests, they are built in higher and drier locations. Construction requires 4-5 days. A clutch of up to six eggs (usually four) is laid on a daily basis, starting typically 2–4 days after the nest has been completed.

There is a fairly high incidence of brood parasitism by brown-headed cowbirds; estimates of 14 percent parasitism of 14 Minnesota nests and 47 percent of 38 Michigan nests are representative. In one Michigan study ten of 22 nests contained a total of 13 cowbird eggs or young, and produced an average of 0.1 yellowthroats and 0.4 cowbirds fledglings per nest. By comparison, 1.9 yellowthroats per nest were raised in the twelve unparasitized nests (Guzy and Ritchison, 1999).

Red-winged Blackbird

This species vies with the western meadowlark and barn swallow for being the most widely distributed and abundant breeding bird in Nebraska, judging from records of the first Nebraska Breeding Bird Atlas survey (Mollhoff, 2001). There are breeding records from every county, with concentrations along the state's major river systems. Its highest density occurs in wetlands dominated by bulrushes or cattails, although in deeper areas where there is more open water the red-winged blackbird may be locally supplanted by the larger yellow-headed blackbird.

Red-winged blackbirds are among the earliest spring songbirds to arrive in Nebraska wetlands, the older males appearing in large flocks and usually taking up territorial positions by early March. Females and younger males begin to arrive about two weeks later, as they winter farther south than older males. Males soon begin singing their familiar oak-a-lee advertisement song, which lasts about 1.5 seconds, and consists of a few brief introductory notes and a prolonged trill. There is some geographic variation in the song, but it can be easily recognized anywhere that it is heard across the species' broad North American range.

The advertising song is usually accompanied by s "song spread" visual display, during which the male's wings are spread enough to expose his red and yellow epaulets, the tail is spread and lowered, and the beak is widely opened. This song is most frequent early in the breeding season, and its rate varies considerably among individual males. The female is very discriminating as to differences among male songs during courtship, but the male is less discriminating in his responses toward the songs of other males. However, both sexes can discriminate local song types from those more distantly removed, and males can discriminate songs of neighbors from those of non-neighbors (Yasukawa and Searcy, 1995).

Territorial sizes vary with habitat type, being smaller in marshes than in uplands, but on average are about 2,000 square meters (or one-half acre), with marsh territories averaging smaller and upland territories larger. Males are polygynous, with as many as 15 females breeding within the territory of a sin-

gle male. The mean harem size from various areas is about five females; up to 90 percent of the males mate polygynously, and the same is true of nearly all females. An estimated 23–48 percent of all offspring are sired by extra-pair males, most often the territorial neighbor (Yasukawa and Searcy, 1995).

Red-winged blackbirds often endure a very high incidence of brood parasitism by brown-headed cowbirds, although the incidence varies by year and geographically, As many as 74 percent of broods have been reported to have cowbirds present. The reproductive success of the blackbirds is reduced as a result, largely through the removal of a host egg each time a nest is parasitized. Host eggs may also be damaged by the harder-shelled eggs of the cowbird, or by efforts of the host female to puncture the cowbird eggs. Parasitized nests are often but not always less successful than unparasitized nests in fledging blackbird young (Kren, 1996, Yasukawa and Searcy, 1995). Female blackbirds are apparently unable to discriminate between their own young and baby cowbirds, and care for them equally. The young birds leave the nest at 10–11 days of age, but remain dependent for some time thereafter, being fed on the territory for up to two weeks, and for as long as three weeks more outside the territory

THE ELKHORN VALLEY WETLANDS

The Elkhorn River has its origins in the Sandhills meadows and springs of southern Rock and Holt counties, and after 276 miles merges with the Platte River near Gretna, in Douglas County. It drains about five million acres, and the majority of its annual flow (60 percent) occurs from March though June. Spring flooding is a significant and almost annual problem on the Elkhorn, which is notable for its meandering course and great number of oxbows. The river's fish population is high; with as many as 40 species reported, and in the upper third of the basin some uncommon to rare species have been found, such as stonecat, grass pickerel, madtom tadpole and bluntnose mimnow (Grier, 1983).

ANTELOPE COUNTY

Antelope County is an Elkhorn River valley county, with less than 900 acres of surface water. The county's area is 857 square miles (averaging 8,0 people per square mile). It contains two wildlife management areas, and its entire east-west width is crossed by the Elkhorn River.

Grove Lake WMA. Area 2,008 acres. Grassland, woods, and a 50-acre reservoir impounding East Verdigre Creek. This trout-rearing facility seasonally attracts ospreys, bald eagles and belted kingfishers. Common floodplain trees include the Plains cottonwood and green ash; bur and red oaks and black walnut are also present. Located three miles north of Royal (Ph. 402/893-2559). Lat./Long. 42.35137/-98.10155.

Hackberry Creek WMA. Area 180 acres. Includes one mile of Elkhorn River frontage, several marshy oxbows, mixed woods and grassland. Located two miles east of Clearwater. Lat./Long. 42.17629/-98.15995.

Red Wing WMA. Area 320 acres. Includes 1.5 mile of Elkhorn River frontage, riparian woods, grassland, and marshes. Located two miles west and three miles north of Neligh. Lat./Long. 42.15268/-98.10664.

CUMING COUNTY

Cuming County is an Elkhorn River valley county, with about 800 acres of surface water. The county's area is 572 square miles (averaging 16.3 people per square mile). It contains one wildlife management area, and its western and southern borders are diagonally bisected by the Elkhorn River.

Black Island WMA. Area 240 acres. Riparian woods and grasslands along 0.75 mile of the Elkhorn River. From the intersection of Highways 275 and 15 (in Stanton County), drive one mile east, 0.5 mile south, 1.5 mile east, then south on entrance road. Lat./Long. 42.00286/-96.9979.

DODGE COUNTY

Dodge County is an Elkhorn and Platte River valley county, with about 1,800 acres of surface water. The county's area is 575 square miles (averaging 6.5 people per square mile). It contains two state recreation areas and one wildlife management area. Almost all its entire southern border is bounded by the Platte River, and the Elkhorn River diagonally bisects its northern and eastern borders.

Dead Timber SRA. Area 150 acres. Riparian frontage (0.5 mile) along the Elkhorn River and a 50-acre oxbow lake. The wooded high bank in the northeastern part of the S. R. A. has many seeps. Located one mile east and one mile south of Crowell, or five miles north and 1.5 mile east of Scribner. State park entry permit required (Ph. 402/664-3597). Lat./Long. 41.71698/-96.69138. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=59

Fremont Lakes SRA. Area 671 acres. Twenty sandpit lakes (totaling 270 acres) and riparian woods in the lower Platte River floodplain. Located four miles west of Fremont on U.S. Highway 30. State park entry permit required (Ph. 402/727-3290). Lat./Long. 41.44169/-96.55833.

Powder Horn WMA. Area 289 acres. Riparian woods along the Elkhorn River, with 0.5 mile of river frontage, plus adjoining grasslands and marshes. Located one mile south of Crowell, or four miles north of Scribner (Ph. 402/370-3374). Lat./Long. 41.71208/-96.69801.

MADISON COUNTY

Madison County is a loess hills and Elkhorn River valley county, with less than 800 acres of surface water. The county's area is 573 square miles (averaging 62.4 people per square mile). It contains two wildlife management areas, and its entire east-west width is crossed by the Elkhorn River.

Oak Valley WMA. Area 640 acres. A hardwood riparian forest along Battle Creek. Located three miles south, one mile west of Battle Creek. Lat./Long. 41.95285/-97.62501.

Yellowbanks WMA. Area 680 acres. Riverine hardwood forest lowlands and bur oak uplands, with 0.5-mile of Elkhorn River frontage. The southern side of the river has the best wetlands. Located four miles east, two miles north of Meadow Grove. To reach the southern side, drive west one mile from the junction of Highways 275 and 121, then go north 0.5 mile, and west two miles. Lat./Long. 42.04354/-97.66397.

STANTON COUNTY

Stanton County is an Elkhorn River valley county, with less than 800 acres of surface water. The county's area is 430 square miles (averaging 15.1 people per square mile). It contains two wildlife management areas, and its entire east-west width is crossed by the Elkhorn River.

Red Fox WMA. Area 537 acres. A 25-acre sandpit lake, a wooded oxbow, and 0.6 mile of Elkhorn River frontage. Located one mile south of Pilger. Lat./Long. 41.98952/-97.05207.

Wood Duck WMA. Area ca. 2,000 acres. Riparian woods bordering the Elkhorn River (1.5 mile of river frontage), with 67 acres of open water, 426 acres of marsh, and 264 acres of riparian woods. Located about two miles south and four miles west of Stanton. Some of the nesting wetland birds include the wood duck, mallard, blue-winged teal, pied-billed grebe, green heron, black-crowned night-heron, and bobolink. American woodcocks can often be seen displaying here in spring. Lat./Long. 41.93084/-97.3153

THE LOUP VALLEY WETLANDS

The Loup River Valley's drainage basin covers nearly a fifth of Nebraska's are, about 15,000 square miles. Counting its longest tributary, the North Loup, it covers a distance of 371 miles from headwaters to mouth. It has three major branches, the North Loup (209 miles), Middle Loup (204 miles) and South Loup (160 miles). Including its other tributaries such as the Cedar, Calamus and Dismal, its overall span collectively totals 1,626 river miles. The North and Middle Loup rise in the marshes and meadows of Cherry and Sheridan counties and are wholly encompassed within the spring-fed Sandhills region, while the South Loup originates in the Sandhills of McPherson County but flows mostly over an upland loess substrate. Because the Sandhills portions of the Loup system are fed by groundwater, their annual and seasonal flows vary only slightly, and their flows increase in volume as a constant rate until they leave the Sandhills region. Thereafter they are increasingly influenced by precipitation patterns. Although each of the Loup rivers once had separate outlets to the Platte, changes in the Platte's channels during late Pleistocene times forced each of the channels eastward into a new, common route (Bouc, 1983).

Along the eastern edges of the Sandhills four irrigation districts have developed along the North and Middle Loups. Irrigation canals now run along the North Loup from near Taylor to near Scotia, and from Milburn to below Scotia. Additionally, a diversion at Arcadia has produced Sherman Reservoir, near Loup City. By the early 1980's, with the development of center-pivot irrigation, nearly 130,000 acres of land were being irrigated by there four projects, and another 64,000 acres were being irrigated by wells associated with private water rights (Bouc. 1983). Many of these center-pivots were placed on lands far too sandy for effective operation, and the sight of center-pivots mired axle-deep in the sand like dinosaurs caught up in tar pits became an object lesson in the economics of unwise Sandhills farming practices.

In addition to serving for irrigation, the Loup Fork River has by diverted by a canal running between Fullerton and Genoa, and through power plants in Monroe and Columbus. The associated water withdrawals have since caused fish populations to decline on the Loup from Genoa to its mouth (Bouc. 1983).

HOWARD COUNTY

Howard County is a Loup River valley county, with nearly 3,000 acres of surface water. The county's area is 570 square miles (averaging 11.75 people per square mile). It contains one state recreation area, two wildlife management areas, and its entire east-west width is crossed by the Loup River.

- Harold W. Andersen WMA. Area 272 acres. One mile of Loup River frontage, plus riparian woods and a marshy oxbow. Located four miles south and two miles west of St. Paul. Lat./Long. 41.14279/-98.50286.
- Leonard Korzoil (formerly Loup Junction) WMA. Area 328 acres. Riparian woods bordered by the junction of the North Loup (one mile of river frontage) and Middle Loup (0.5 mile of river frontage) rivers, plus marshes and grassy areas. The riparian forest includes the Plains cottonwood, green ash, box elder, silver maple, mulberry and red cedar. From St. Paul, drive three miles north, two miles east and 0.5 mile north. Lat./Long. 41.2694/-98.4093.

NANCE COUNTY

Nance County is a Loup–Platte River valley county, with almost 3,000 acres of surface water. The county's area is 441 square miles (averaging 7.9 people per square mile). It contains four wildlife management areas, and its entire east-west width is crossed by the Loup River.

- Loup Lands WMA. Area 485 acres. Mostly riparian woods, plus 30 acres of marsh and access to the Loup River. The site's many sandbars provide nesting habitat for least terns. Located three miles southwest of Genoa on Nebraska Highway 22. Lat./Long. 41.40776/-97.78257.
- Prairie Wolf WMA. Area 972 acres, including 350 acres of riparian woods, 60 acres

of marsh and river wetlands, and over 500 acres of non-wooded habitats. Sedge wrens, swamp sparrows and common yellowthroats are among the likely breeders. Includes 1.5 mile of frontage along the Loup River, plus restored grasslands and marshes. Located one mile south and two miles west of Genoa. Lat./Long. 41.41465/-97.73921.

Sunny Hollow WMA. Area 160 acres. Two marshes and grassy uplands. Located four miles south, one mile west of Genoa, in the isolated sandhills area of the Loup Valley. One of the few remaining wetlands in this otherwise largely destroyed unique biological region. Located four miles south and one mile west of Genoa. Lat./Long. 41.37685/-97.73845.

PLATTE COUNTY

(see also Todd Valley Playa Wetlands, Chapter 7)

Platte County is a Loup River–Platte River county, with almost 3,000 acres of surface water). The county's area is 675 square miles (averaging 46.1 people per square mile). It contains two wildlife management areas. Its southern border is bounded by the Platte River, and the Loup River extends over most of its southern portion, until merging with the Platte.

George D. Syas WMA. Area 917 acres, with 1.5 mile of Loup River frontage. An abandoned river channel cuts diagonally through this site, forming sloughs and wetlands. The floodplain forest includes the Plains cottonwood, eastern red cedar, green ash, hackberry, catalpa, box elder and black walnut. From Genoa, drive 2.5 miles south on Highway 39, east one mile, and north one mile. Lat./Long. 41.43304/-97.6818.

SHERMAN COUNTY

Sherman County is a Loup River valley county, with over 4,000 acres of surface water (mostly reservoir acreage). The county's area is 566 square miles (averaging 5.5 people per square mile). Sherman County contains two state recreation areas, and is crossed diagonally northwest to southeast by the North Loup River.

Sherman Reservoir SRA/WMA. Combined area ca. 8,000 acres, including a 2,845-acre reservoir on Oak Creek. Located four miles east and one mile north of Loup City. Park permit needed for S. R. A. (Ph. 308/745-0230). Lat./Long. 41.32469/-98.90856.

VALLEY COUNTY

Valley County is a Loup River valley county, with nearly 3,000 acres of surface water. The county's area is 568 square miles (averaging 7.7 people per square mile). It contains one state recreation area/wildlife management area, and its entire east-west width is crossed diagonally by the Calamus and North Loup rivers.

Davis Creek SRA/WMA. Combined area ca. 2,000 acres, including a 1,145-acre reservoir. Located about three miles south of North Loup, on the Greeley–Valley county line (one mile south and six miles west of the junction of state highways 11 & 22). Park permit needed for S. R. A (Ph. 308/728-3221). Lat./Long. 41.42752/-98.76502.

THE REPUBLICAN VALLEY WETLANDS

The Republican River provides a case study on how not to manage a river. Arising on the plains of eastern Colorado, the Republican River enters Nebraska's southwestern corner in Dundee County, parallels the Platte River for about 200 miles, and then turns southeast into Kansas. Because of this tri-state course, all three states have quarreled over water rights, and those thorny issues still involve long-running bitter legal suits between Nebraska and Kansas.

The Republican River now occupies a 25,000 square mile basin, but in spite of this vast water-collection region it has at times nearly run dry during recent drought years (2000–2009). Yet, in 1935, torrential May rains in eastern Colorado and southwestern Nebraska exploded the river

to an estimated 200 times normal flow at McCook. The resulting floods took the lives of 113 people and 20,000 head of livestock. A later 1947 flood of the Medicine and Red Willow creeks cascaded into the Republican River near Cambridge, taking another 13 lives (Hoffman, 1983).

Since then, a series of dams have tamed the river. A dam finished in 1949 on Medicine Creek produced Harry Strunk Reservoir, and in 1950 a dam on Frenchman Creek produced Enders Reservoir. A mainstem dam at Republican City was finished in 1952, producing Harlan County Reservoir. Trenton Dam, finished in 1954, formed Swanson Reservoir, and in 1962 a dam on Red Willow Creek resulted in the formation of Hugh Butler Lake (Hoffman, 1983). All these reservoirs, built mostly for flood control have brought nearly 900,000 acres of water to the region, and have effectively controlled regional flooding.

Now, flooding in the Republican Valley is not nearly such as threat as is de-watering, as a result of excessive irrigation. The Frenchman River, a river perhaps a million years old, was effectively destroyed by uncontrolled deepwater pumping of the Ogallala aquifer in less than 30 years (Hoffman, 1983).

DUNDY COUNTY

Dundy County is a Republican River valley county, with very little surface water, mostly consisting of reservoir acreage and the upper Republican River wetlands. The county's area is 920 square miles (averaging 2.3 people per square mile). Dundy County contains one state recreation area, and its entire east-west width is crossed by the Republican River.

Rock Creek Lake SRA. Area 164 acres. This site has a 50-acre impoundment and fish hatchery. The lake forms an extensive marsh, and is a magnet for water birds in this arid land. Wetland birds reported from here (some possibly remaining to nest) include the blue-winged teal, ruddy duck, eared and western grebes, Virginia rail, belted kingfisher, marsh wren and yellow-headed blackbird. Jon Farrar (2004) listed 32 birds as a "sampler" of the area's bird life, of which most are open-country and forest-edge species, as well as about ten typical wetland species such as the spotted and upland sandpipers. Located four miles northwest of Parks. State park entry permit required (Ph. 308/394-5118). Lat./Long. 40.09322/-101.76296.

HARLAN COUNTY

Harlan County is a Republican River valley and Rainwater Basin county, with nearly 15,000 acres of surface water, mostly reservoir acreage. The county's area is 553 square miles (averaging 6.3 people per square mile). It contains two state wildlife management areas, and the county's entire east-west width is crossed by the Republican River and its impounded Harlan County Reservoir.

Harlan County Reservoir. Area ca. 16,000 acres upland, and a 13,338-acre reservoir (when full). The largest reservoir in south-central Nebraska, on the Republican River. There is a double-crested cormorant colony at the upper (west) end, and a great blue colony below the dam. The western end (off state highways 136 & 183) is swamp-like, with flooded trees. Jon Farrar (2004) listed 59 birds as a "sampler" of the area's bird life, of which 17 were typical wetland species, and about 20 were forest and forest-edge species such as long-eared owl, lazuli and indigo buntings, and the blue, rose-breasted and black-headed grosbeaks. The reservoir is located between Republican City and Alma, and the dam is situated two miles south of U.S. Highway 136, Republican City, on Berrigan Road. The site is managed by U.S. Corp of Engineers; no entry fee (Ph. 308/799-2105).

South Sacramento WMA. Area 77 acres playa wetland and 90 acres upland. Located four miles east and two miles north of Ragan. Lat./Long. 40.31825/-99.23166.

Southeast Sacramento WMA. Area 140 acres playa wetland and 45 acres upland. Located three miles east and one mile north of Ragan. Lat./Long. 40.34412/-99.21895.

HITCHCOCK COUNTY

Hitchcock County is a Republican River valley county, with over 5,600 acres of surface water, mostly reservoir acreage. The county's area

is 710 square miles (averaging 4.2 people per square mile). It contains one state recreation area/wildlife management area, and its entire east-west width is crossed by the Republican River.

Swanson Reservoir SRA/WMA. Area (combined SRA/WMA) 4.124 acres upland, and a 4,973-acre reservoir. Located on the Republican River, three miles west of Trenton on U.S. Highway 34. Lat./Long. 40.15677/-101.06213.

RED WILLOW COUNTY

Red Willow County is a Republican River valley county at the southwestern edge of the Rainwater Basin, with about 2,700 acres of surface water. The county's area is 717 square miles (averaging 15.2 people per square mile). Red Willow County contains one state recreation area, and its entire east-west width is crossed by the Republican River.

Red Willow SRA. See Frontier County.

WEBSTER COUNTY

Webster County is a Republican River valley county, with over 2,600 acres of surface water. The county's area is 575 square miles (averaging 6.4 people per square mile). Webster County contains two state wildlife management areas, and its entire east-west width is crossed by the Republican River.

Elm Creek WMA. Area 120 acres. Mostly wooded, with a creek and slough at one end. Located three miles south of Cowles. Lat./Long. 40.12343/-98.44595.

Indian Creek WMA. Area 114 acres. Riparian woods along the Republican River. Located one mile south of Red Cloud. Lat./Long. 40.06326/-98.52348.

MISCELLANEOUS RIVERINE WETLANDS

BOONE COUNTY

Boone County is a loess hills and Beaver Creek Valley county, with about 1,100 acres of surface water. The county's area is 687 square miles (averaging 8.3 people per square mile). It contains one state wildlife management area, and its entire east-west width is crossed diagonally by Beaver Creek, a tributary of the Loup River. Beaver Creek valley has many privately owned wetlands, some of which may be seen by driving U.S. Highway 14 north from Albion for eight miles, then taking Beaver Valley Road northwest. This road closely follows the creek for about 12 miles.

Beaver Bend WMA. Area 27 acres. A wetland along Beaver Creek, with riparian woodland habitat. Located one mile northwest of St. Edward. Lat./Long. 41.58544/-97.88427.

CHASE COUNTY

Chase County is a southwestern Sandhills–shortgrass and Frenchman Creek county, with about 2,200 acres of surface water, nearly all of which consists of reservoirs. The county's area is 895 square miles (averaging 4.4 people per square mile). It contains state recreation areas, one state wildlife management area, and its entire east-west width is crossed by Frenchman River, a tributary of the Republican River.

Enders Reservoir SRA/WMA. Area of S. R. A. 2,222 acres, WMA. 3,643 acres. A 1,700-acre reservoir on Frenchman Creek, with about 26 miles of shoreline when full. The upper half of the reservoir is a waterfowl refuge and is closed to traffic during fall and early winter. Shoreline woodlands are limited, but the ravines are wooded. The reservoir is surrounded by about 2,000 acres of arid sandsage and other grasslands. There are marshes at the upper end of the reservoir that are unstudied as to breeding species but might support nesting Virginia rails and other wetland birds. Wetland birds that have been seen here (most only as likely migrants) include the western and Clark's grebes, red-necked grebe, common loon, wood duck, American white pelican, double-crested cormorant, green heron, American avocet, white-faced ibis, belted kingfisher and yel-

low-headed blackbird. Jon Farrar (2004) listed 28 birds as a "sampler" of the area's bird life, of which ten are typical wetland-dependent species. Located at the south edge of Enders. State park entry permit required (Ph. 308/394-5118). Lat./Long. 40.4334/-101.51936. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=71

FRONTIER COUNTY

Frontier County is a transitional mixed-grass–shortgrass and county in the Republican River drainage, with about 3,500 acres of surface water, nearly all of which consists of reservoirs. The county's area is 975 square miles (averaging 2.9 people per square mile). It contains two state recreation/wildlife management areas, and is crossed diagonally by Medicine Creek and Red Willow Creek, both tributaries of the Republican River.

Medicine Creek SRA/WMA. Total Area 6,726 acres upland and a 1,850-acre reservoir on Medicine Creek. Over 900 acres of seasonal wetlands, and riparian woods with Plains cottonwood, American elm, hackberry, box elder and eastern red cedar. Jon Farrar (2004) listed 49 birds as a "sampler" of the area's bird life, of which most are forest and forest-edge species, as well as some more typical wetland species. Wetland species include Bell's vireo, northern rough-winged, barn, tree and cliff swallows, common yellowthroat and yellow-breasted chat. Probable woodland breeders include the eastern screech-owl, red-headed and red-bellied woodpeckers, northern flicker, eastern and Say's phoebes, rose-breasted and black-headed grosbeaks, lazuli and indigo buntings, as well as orchard and Baltimore orioles. Located two miles west and seven miles north of Cambridge, State park entry permit required for S. R. A. (Ph. 308/697-4667). Lat./Long. 40.37919/-100.21197. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=113

Red Willow SRA/WMA. Combined area 2,986 acres upland, with a 1,628-acre reservoir on Red Willow Creek. Located 11 miles north and two miles west of McCook on U.S. Highway 83. The recreation area extends partly into Red Willow County. State park entry permit required for S. R. A. (Ph. 308/345-6507). Lat./Long. 40.35979/-100.66351. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=149

GAGE COUNTY

Gage County is in a region of loess and glacial drift, and is crossed diagonally by the Big Blue River It has about 2,000 acres of surface water, nearly all of which consists of reservoirs. The county's area is 855 square miles (averaging 27.5 people per square mile). It contains one national monument, one state recreation area, three state wildlife management areas, and is crossed diagonally by the Big Blue River.

Diamond Lake WMA. Area 320 acres. Grasslands around a 33-acre reservoir, on a tributary to Big Indian Creek. Located 3.5 miles west of Odell. Lat./Long. 40.04008/-96.86897.

Homestead National Monument of America. Area 195 acres. Includes riparian woods along the Big Blue River, and restored prairie. Located four miles northwest of Beatrice on State Highway 4. A federal historic monument, commemorating the 1862 Homestead Act, and the site of the first homestead parcel granted. The local bird checklist has 120 species, including 20 water-dependent species and over 80 riparian woodland or forest species. and Address 8523 W. Highway 4, Beatrice, NE. (Ph. 402/223-3514). URL: http://www.nps.gov/home/

Rockford Lake SRA. Area 436 acres, including a 150-acre reservoir on Bloody Run Creek. Located one mile east and 1.5 mile south of Rockford, or seven miles east of Beatrice on State Highway 4, then two miles south. State park entry permit required (Ph. 402/471-0641). Lat./Long.

40.22091/-96.58174. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=154

HAYES COUNTY

Hayes County is a transitional Sandhills–shortgrass county, with less than 800 acres of surface water, nearly all of which consists of reservoirs. The county's area is 713 square miles (averaging 1.4 people per square mile). It contains one state wildlife management area, and is crossed diagonally by Frenchman Creek and Red Willow Creek.

Hayes Center WMA. Area 78 acres. A 40-acre reservoir on Willow Creek, with a cattail marsh at its upper end, native grasslands, and scattered woods. Located 12 miles northeast of Hayes Center via winding country roads. Lat./Long. 40.59241/-100.93071.

KIMBALL COUNTY

Kimball County is a southwestern shortgrass county, with about 1,000 acres of surface water, nearly all of which consists of reservoirs. The county's area is 952 square miles (averaging 3.9 people per square mile). It contains one state recreation area, and its entire east-west width is crossed by Lodgepole Creek.

Oliver Reservoir SRA. Area 1,187 acres. A 270-acre reservoir on the often dry Lodgepole Creek, in shortgrass habitat and in a region where surface water is a rarity. Jon Farrar (2004) listed 47 birds as a "sampler" of the area's bird life, of which most are open-country or forest-edge species, as well as 11 wetland species including eared, pied-billed and western grebes, and white-faced ibis. Located ten miles west of Kimball on U.S. Highway 20. State park entry permit required (Ph. 308/436-3777). Lat./Long. 41.22453/-103.82729. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=255

JOHNSON COUNTY

Johnson County is in a region of glacial drift and loess, with about 500 acres of surface water, nearly all of which consists of reservoirs. The county's area is 376 square miles (averaging 12.8 people per square mile). It contains two state wildlife management areas, and is crossed diagonally by the North Fork of the Big Nemaha River.

Hickory Ridge WMA. Area 444 acres, A small reservoir, grasslands and wooded bottomlands along the Lost Branch of Yankee Creek. Located four miles east and 1.5 miles south of Crab Orchard. Lat./Long. 40.3133/-96.35556.

PAWNEE COUNTY

Pawnee County is in a region of glacial drift and loess, with less than 1,000 acres of surface water. The county's area is 432 square miles (averaging 6.5 people per square mile). It contains seven state wildlife management areas, and is crossed diagonally by the Big Nemaha River.

Burchard Lake WMA. Area 560 acres. A 150-acre reservoir, surrounded by hilly native grasslands and shoreline hardwoods. Notable for its resident but greater prairie-chicken flock and its very rare massasauga snake population. Two free-access and first-come prairie-chicken blinds are present. However, as the likely result of excessive disturbance, the lek has had little bird activity in recent years. From Burchard, travel three miles north, three miles east, and two miles south. Lat./Long. 40.16796/-96.30309.

Table Rock WMA. Area ca. 640 acres. A wooded floodplain and grassland along the Nemaha River. Located just east of Table Rock, on the north side of U.S. Highway 4. Lat./Long. 40.18366/-96.06326.

Chapter 6

The Sandhills Wetlands Region

The ecology and natural history of the Nebraska Sandhills has been reviewed earlier (Johnsgard, 1995). The Sandhills region is by far the largest of Nebraska's ecosystems, covering about 19,000 square miles, and consisting of dunes that on the basis of recent evidence were probably first formed at the end of the final (Wisconsinan) glacial period, less than 15,000 years ago rather than the much earlier times originally postulated by geologists (Ahlbrandt, Swinehart and Marones,, 1984; Loope and Swinehart, 2000; Maher, Engelmann and Shuster, 2003).

The Sandhills support the largest number of the state's wetlands, totaling over one million acres. Rundquist (1983) estimated that these wetlands consist of 1.13 million acres of wet meadows and 177,000 acres of open water. Ginsberg (1984) noted that estimates of the number of lakes in the Sandhills have varied widely, but there are probably well over 1000 lakes present, 95 percent of which are no deeper than eight feet. She defined Sandhills lakes as those wetlands in which the water table is at the land surface or above it for most of the year, wet meadows as those as those wetlands in which the water table is at the land surface or below it for most of the year, and marshes as a transitional wetland type connecting the two. By this definition, in some cases a wetland may be defined as a lake in the spring, but not in the fall, when the water table declines. These between-season and between-year variations make conclusive lake inventories impossible.

Lakes also vary as to their relative connections with groundwater. Groundwater lakes may have a direct groundwater flow in and out of the lakes through local underground flow systems, while others (still groundwater lakes) may have only poor connections to the groundwater reservoir. Still others (perched lakes) may have no connection with groundwater. Additionally, the Sandhills lakes vary greatly in their alkalinity. Most of the lakes west of the Chadron arch (a geological uplift extending from Sheridan County southeast to Hooker County) are much more highly alkaline than those east of the arch, for reasons that are still somewhat speculative (Ginsberg, 1984).

The relative wealth of water in the Sandhills results from the fact that the Ogalalla aquifer lies directly below the dunes, storing nearly one billion acre-feet of water. Besides covering an area of about a quarter of the Nebraska's total area, the Sandhills have extremely low human population densities and very few improved roads. They thus represent the nearest thing to a true wilderness area anywhere east of the Rockies, in addition to supporting the largest intact area of mixed-grass prairie that still exists south of Canada. The region's other superlatives include the remarkable fact that it rather inexplicably contains the most important waterfowl and shorebird breeding area south of the Dakota pothole country. Thousands of shallow, often small and unnamed wetlands are present that range from being some of the most alkaline waters in the western hemisphere to highly productive lakes and marshes that have an amazing diversity of plant and animal life.

In spite of the great variety of water-dependent plants and animals that exist in the region, precipitation in the Sandhills is no different in total (about 18-26 inches annually) from that supporting mixed-grass prairie to the north and south. The rain that falls is immediately drawn down through the sand to join the waters of the vast Ogallala aquifer, which sometimes almost reaches the land surface. In such places the low inter-dune depressions are sub-irrigated, and in others hundreds of permanent marshy wetlands are present as a result of this high water table. In still other locations artesian springs emerge from the bases of sand dunes to form small streams that eventually join others and flow eastwardly, southeastwardly and northeastwardly out of the Sandhills, in the form of rivers and permanent creeks (Johnsgard, 1995).

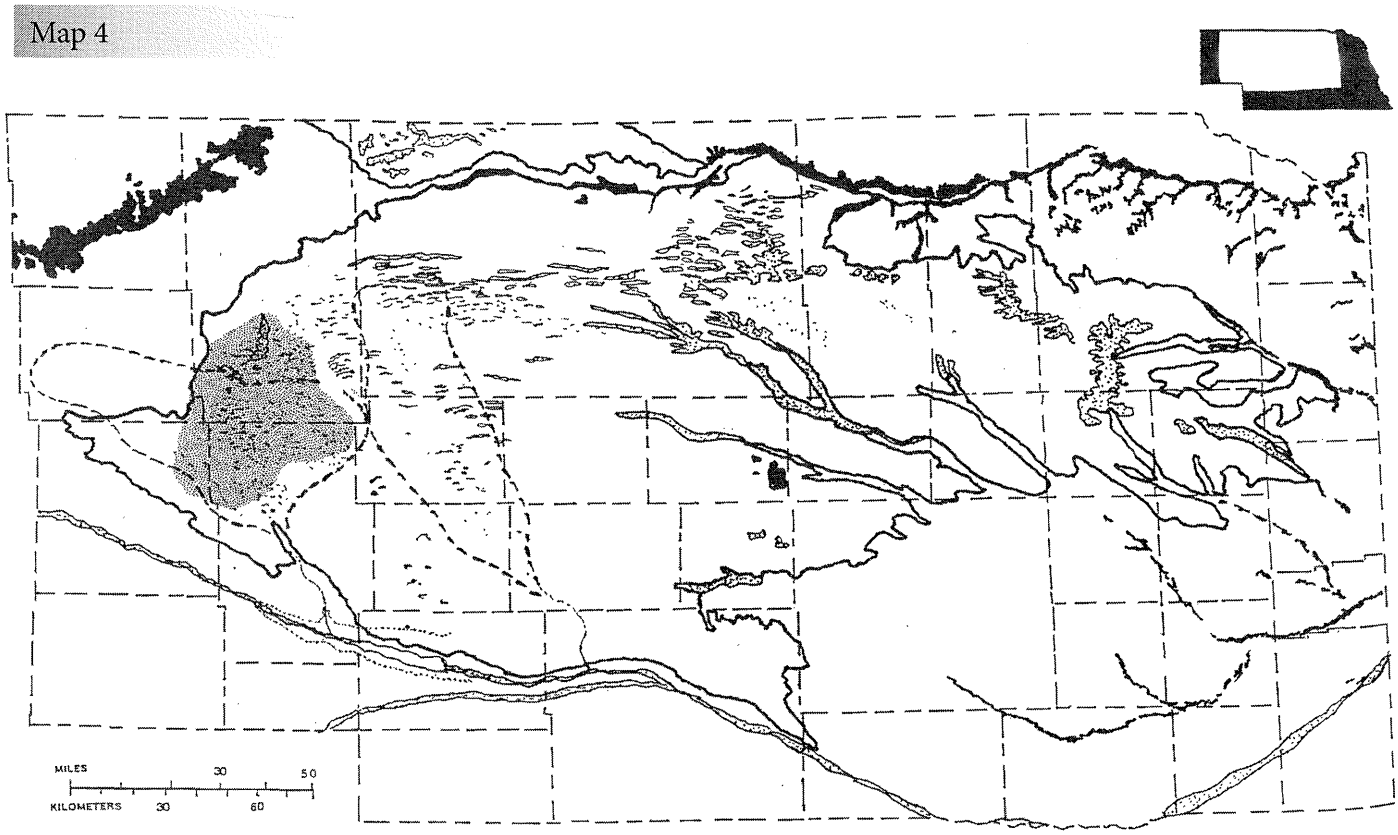
About 100–110 bird species breed in the Sandhills, which represents about half of the state's

total breeding avifauna. The Sandhills are easily the most important breeding habitat for water-, marsh- and shoreline-dependent birds in the state. The western Sandhills are the state's primary breeding area for the western grebe, canvasback. long-billed curlew, willet, American avocet and black-necked stilt, and the Sandhills generally are the major or only Nebraska breeding grounds for additional species such as the trumpeter swan, American wigeon, ruddy duck, eared grebe, American bittern, black-crowned night-heron, white-faced ibis and Forster's tern. They are also of great national and international importance to millions of migrating waterfowl and shorebirds **(Table 10).**

Additionally, at least 50 species of mammals (about 60 percent of the state's total) are present in the Sandhills, and about the same number of native fish (also about 60 percent of the state's total). Three fish species, the finescale dace, northern red-bellied dace and Plains topminnow have Nebraska ranges that are centered on the Sandhills. There are also an estimated 26 species of reptiles and amphibians in the Sandhills region (about half the state's total herptile fauna). Its marshes support by far the nation's largest known population of the rare Blanding's turtle.

The Sandhills are notable for their relatively low species diversity of terrestrial flora, a measure of the hardscrabble existence that plants encounter when trying to survive in this difficult environment. I have estimated (Johnsgard, 1995) that in six central Sandhills counties there is a total of about 450 reported vascular plant species. By comparison, the 800 acres of tallgrass prairie at Spring Creek Prairie near Lincoln supports close to 400 plant species, and the approximately 2,000 acres in Fontenelle Forest and Neal Woods nature centers near Omaha have nearly 500 species (Barth and Ratzlaff, 2004; Ratzlaff and Barth, 2007).

Map 4



Distribution of wetlands in the Sandhills region, showing areas of poor drainage and high alkaline wetlands in the western sandhills (dark stippling), riparian woodlands (light stippling) and other regional forested areas (inked). Dune-blocked drainages of Blue and Birdwood creeks are shown by dashed lines. The inked areas indicate the riparian woodlands of the Niobrara Valley and (upper left) the distribution of the Pine Ridge forests. After Johnsgard (1995).

Table 10

Relative Spring and Summer Abundance of Wetland-associated Birds in three Nebraska Sandhills National Wildlife Refuges*

Species

- Blue-winged teal (28)
- Red-winged blackbird (28)
- Barn swallow (28)
- Mallard (27)
- Northern shoveler (26)
- Gadwall (25)
- Killdeer (25)
- Wilson's snipe (25)
- Upland sandpiper (24)
- Common yellowthroat (23)
- Redhead (20)
- Marsh wren (20)
- Northern pintail (19)
- Canada goose (15)
- Yellow-headed blackbird (18)
- American coot 18)
- Wilson's phalarope (18)
- Black tern (18)
- Forster's tern (16)
- Long-billed curlew (16)
- Ruddy duck (16)
- Sora (16)
- Double-crested cormorant (16)
- Pied-billed grebe (15)
- Eared grebe (15)
- Western grebe (15)
- American bittern (15)
- Northern harrier (14)
- Bobolink (13)
- American wigeon (13)
- Willet(12)
- Virginia rail (12)
- American avocet (12)
- Canvasback (12)
- Greater prairie-chicken (12)
- Trumpeter swan (9)
- Belted kingfisher (9)
- Black-crowned night-heron (8)
- Lesser scaup (7)
- Great blue heron (7)
- Green-winged teal (7)
- Spotted sandpiper (6)
- Franklin's gull (6)
- Northern rough-winged swallow (6)
- Swamp sparrow (6)
- Wood duck (4)
- Cinnamon teal (4)
- Black-necked stilt (4)
- Song sparrow (2)

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* Based on summed spring and summer abundance estimates for wetland-associated birds at Crescent Lake, Valentine, Fort Niobrara national wildlife refuges, as identified and summarized by Novacek (1989).* Abundance key: Abundant = 5, Common = 4, Uncommon = 3, Occasional = 2, Rare – 1.

Lowland vegetation types in the Sandhills are of two general types. Native wetlands typically include prairie cordgrass, bluejoint reedgrass, reed canarygrass, water hemlock, and many species of sedges and rushes. Subirrigated sites usually have a water table from one to five feet below the surface, and have plants much like the tallgrass prairies to the east, including big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass, various wheatgrasses and others (Nichols, 1984).

Many wetland plants are endemic to, or nearly endemic to, the Sandhills. They include several fen-adapted species (Table 11) that are post-Pleistocene survivors now often separated for hundreds of miles from other populations (e.g., adder's tongue, bogbean, cotton-grass, flat-top aster, marsh St. John's-wort, mud sedge, swamp lousewort and wood lily). There are also many other more generally distributed wetland species throughout the Sandhills (e.g., great water dock, Hall's bulrush, marsh bellflower, marsh fern, prairie sedge, and sensitive fern).

The Sandhills region contains two major national wildlife refuges in Nebraska (Crescent Lake N. W. R. and Valentine N. W. R.), as well as one refuge (LaCreek N. W. R.) that is located just north of the Nebraska–South Dakota border in Bennett County. Nearly all of the Sandhills lands other than national wildlife refuges, state parks, and state wildlife management areas are in private ownership, primarily by cattle ranchers and a few bison ranchers.

A consortium of private landowners, conservation groups and governmental agencies have formed the Sandhills Task Force, which is concerned with maintaining the ranching tradition, protecting wetlands, and monitoring the overall ecology of the Sandhills. Their address is: Sandhills Task Force Coordinator U. S. Fish & Wildlife Service, P. O. Box 1686, Kearney, NE 68848 (Ph. 308/236-5015). A Sandhills Journey Scenic Byway Visitor Center is located at Broken Bow (44206 NE Hwy 2; Ph. 308/872-8331).

Natural History Profiles of Some Sandhills Wetland Species

Northern Harrier

It seems not quite fair to claim the northern harrier as a North American wetland bird; I have seen this species coursing gracefully over the lowlands and upland moors of Scotland and northern England, where it is called the hen harrier. A similar species of harrier confusingly called the marsh harrier also occurs in Britain. It was probably for such reasons that the common English name "northern harrier" was adopted a decade or more ago in preference to 'marsh hawk," its traditional North American name. Somehow "marsh hawk" seems most appropriately descriptive of this bird. Its current name "harrier" refers not to the birds' unlikely preying on hares, but to the harrying behavior these birds exhibit toward their prey.

Probably the happiest choice for its name is the Latin one: Circus refers to the undulating or even almost looping (thus "circular") flights of territorial males in early spring as they define their territories, and cyaneus describes the somewhat bluish tint to the adult male's gray plumage, which contrasts with its darker, "dipped-in-ink" wingtips. The species is generally distinctly northern in its North American breeding distribution, but I have seen their nests in the western Nebraska Sandhills, and there are local breeding records south as far as the Gulf Coast.

More than any other large hawk of the central plains, the adult northern harrier exhibits strong plumage dimorphism of the sexes as well as moderate dimorphism in body mass. Females are not only larger than males by about 40 to 50 percent but are also a rich chocolate brown on their upperparts, perhaps allowing them to blend in with their dead-grass nesting environment. Juveniles are basically the same color dorsally as females for their first year, but are a much richer cinnamon-rufous on their underparts. Both juveniles and adults of both sexes have white rump patches that, together with their long tails and wings, provide for easy identification. Their long wings allow the birds to glide at rather slow speeds. They maintain their aerial stability by adopting a distinct upward tilt in their wing positioning, much like gliding turkey vultures. Another usual feature of harriers is their development of somewhat owl-like facial disks. These feathers, together with unusually well-developed hearing, allow the birds to detect the movements of even small rodents such as mice and allow for dependence on other rodents

Indicator, Rare and Widespread Plant Species in Six Nebraska Sandhills Fens*

Alismataceae – Water-plantain Family -
Arrowhead. *Sagittaria latifolia.*

Apiaceae (= Umbelliferae) – Parsley Family -
Bulbous water hemlock . *Cicuta bulbifera.***
Water parsnip. *Sium suave.*

Asclepiadaceae– Milkweed Family
Swamp milkweed. *Asclepias incarnata.*

Asteraceae (= Compositae) – Sunflower Family
Bog aster. *Aster borealis.**#
Panicled aster. *Aster lanceolatus.*
Willowleaf aster. *Aster prealtus, var. nebraskensis.*
Flat-top aster. *Aster umbellatus.**#
Nodding beggarsticks. *Bidens cernua.*
Tickseed sunflower. *Bidens coronata.*
Spotted Joe Pye weed. *Eupatorium maculatum.*
Black-eyed Susan. *Rudbeckia hirta.*
Canada goldenrod. *Solidago canadensis.*
Giant goldenrod. *Solidago gigantea.*
Western ironweed. *Vernonia fasciculata.*

Balsaminceae – Touch-me-not Family
Spotted touch-me-not. *Impatiens capensis.*

Brassicaceae – Mustard Family
Bitter cress *Cardamine pennsylvanica.**#

Campanulaceae – Bellflower Family
Marsh bellflower. *Campanula aparinoides.*
Blue lobelia. *Lobelia siphilitica.*

Caryophyllaceae – Pink Family
Long-leaved stitchwort. *Stellaria longifolia.*

Clusiaceae – Mangosteen Family
Marsh St. John's-wort, *Triadenum fraseri.**#

Cyperaceae – Sedge Family
Water sedge. *Carex aquatilis.**#
Sedge. *Carex diandra.**#
Sedge. *Carex interior.*
Lacustrine sedge. *Carex lacustris.*
Mud sedge. *Carex limosa.**#
Nebraska sedge. *Carex nebraskensis.*
Woolly sedge. *Carex pellita.*
Prairie sedge. *Carex prairea. **#
Sedge. *Carex sartwellii,*
Sedge. *Carex stipata.*
Sedge. *Carex tetanica.*
Spike-sedge. *Eleocharis elliptica.*
Cotton-grass. *Eriophorum angustifolium. **#
Slender cotton-grass. *Eriophorum gracile.**#
Hardstem bulrush. *Schoenoplectus (Scirpus) acutus.*
Common threesquare. *Schoenoplectus (Scirpus) pungens.*
Softstem bulrush. *Schoenoplectus(Scirpus taberemontani.*

Dryopteridaceae – Fern Family (= Polypodiaceae)
Marsh fern. *Thelypteris palustris.*

Gentianaceae – Gentian Family
Closed (bottle) gentian. *Gentiana andrewsii.#*

Juncaceae – Rush Family
Rush. Juncus articulatus. **
Baltic rush. *Juncus arcticus balticus.*
Rush. *Juncus canadensis.***
Dudley's rush. *Juncus dudleyi.*

Lamiaceae (= Labitae) – Mint Family
Field mint. *Mentha arvensis.*
Marsh scullcap. *Scutellaria galericulata*

Liliaceae – Lily Family
Wood lily *(Lilium philadelphia). **#

Menyanthaceae – Buck-bean family
Bog buckbean. Menyanthes trifoliata. **#

Onagraceae – Evening Primrose Family
Narrow-leafed willow-herb. *Epilobium leptophyllum.*

Ophioglossaceae – Adder's-tongue Family
Adder's-tongue. *Ophioglossum pusillum.**#

Orchidaceae – Orchid Family
Twayblade. *Liparis loseli. **

Poaceae – Grass Family
Redtop. *Agrostis stolonifera.*
Fringed brome. Bromus ciliatus.
Northern reedgrass. *Calamagrostis stricta.*
Fowl manna grass. *Glyceria striata.*
Rice cutgrass. *Leersia oryzoides.*
Muhly. *Muhlenbergia glomerata.#*
Common reed. *Phragmites australis.*
Prairie cordgrass. *Spartina pectinata.*

Polygonaceae – Buckwheat Family
Water smartweed. *Polygonum amphibium.*
Pale (Nodding) smartweed. *Polygonum lapathifolium.*
Great water dock. *Rumex orbiculatus.*

Table 11, Cont

Indicator, Rare and Widespread Plant Species in Six Nebraska Sandhills Fens*

Primulaceae – Primrose Family
Tufted loosestrife. *Lysimachia thyrsiflora.*

Ranunculaceae – Buttercup Family
Marsh-marigold. *Caltha palustris.***#*

Rubiaceae – Bedstraw Family
Small bedstraw. *Galium trifidum.*

Salicaceae – Willow Family
Meadow willow. *Salix petiolaris.*

Scrophulariaceae – Figwort Family
Swamp lousewort. *Pedicularis crenulata.* **#*

Sparganiaceae – Bur-reed Family
Bur-reed. *Sparganium eurycarpum.*

Thelypteridaceae (Polypodiaceae) – Fern Family
Marsh fern. *Thelypteris palustris.*

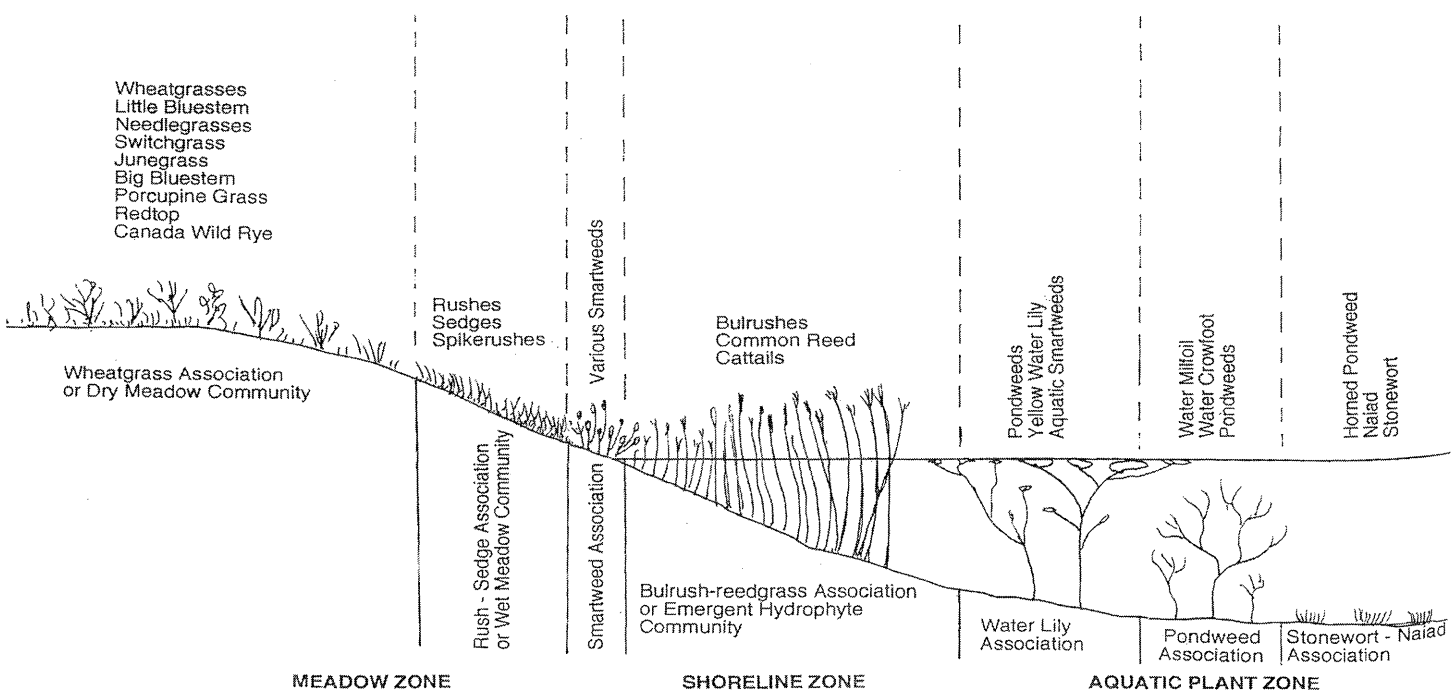
Typhaceae – Cattail Family
Broad-leaved cattail. *Typha latifolia.*

Urticaceae – Nettle Family
Clearweed. *Pilea fontana.*

Violaceae – Violet Family
Northern bog violet. *Viola nephrophylla.*

* Steinauer, Rolfsmeier and Hardy (1996). Species shown with a "#" were regarded by them as fen indicator species. Those species shown with two asterisks are designated as Nebraska Natural Heritage element species. Underlined species are those that were present in all of six fens studied.

Fig. 19



Profile of wet meadow and aquatic plant communities in the Nebraska Sandhills, indicating typical plants for each vegetational zone. After Johnsgard (1995).

and passerine birds such as meadowlarks. Unlike prairie falcons, which also often capture meadowlarks, harriers do not capture such birds during prolonged chases but are more likely to grab them unawares while they are perched or hiding among grasses. During summer the prey spectrum broadens and especially is likely to include older nestlings and recently fledged or at least somewhat ambulatory birds. A typical prey item is tiny relative to the harrier's body mass and on average weighs only about two ounces, which is closer in size to a northern cardinal than a meadowlark. Rarely prey as large as about two pounds may be taken.

The birds have quite long tarsi, somewhat like those of barn owls, but have fairly weak toes and talons, at least as compared to those of buteo hawks. Like those of barn owls, their long tarsi might be useful for reaching down into tall grass to grab prey. The success rate of attacks on birds is lower than that on mammals, and vole-hunting over snow cover is more successful than hunts done in the absence of snow. Prey is captured using varied strategies, including gliding or powered low-altitude flights over fairly long distances, shorter quartering flights, and flights that follow vegetational edges, such as fencerows. Pounces may be preceded by hovering, quick turns or by direct attacks without change of speed or direction. Early morning and evening hunts are commonplace, but no true nocturnal hunting in the manner of owls seems to have been reported. Under favorable foraging conditions the birds may cache excess prey for later consumption, at least during the breeding season. Not surprisingly, females tend to take larger prey than do males during the breeding season, based on typical sizes of items that are brought back to the nest.

Wintering by this species extends surprisingly far southward, with birds seen occasionally in Panama, and more rarely individuals reach northern South America. However, the majority of Great Plains birds seem to winter in the southern states and Mexico. Peak numbers in the Great Plains occur in various parts of the southern plains. Many of these concentrations are located near wildlife refuges, and there the birds are prone to specialize on wounded waterfowl. During the winter, foraging individuals may cover about 100 miles per day, mostly within localized hunting territories up to a square mile in area. Females exclude the smaller males from such territories. It seems likely that young birds winter farther south than adults, and females perhaps winter north of males, based on their relative body masses and consequent probable cold tolerance. Yet, in spring males precede females as to their arrival times on northern nesting grounds, probably because of the importance of establishing good breeding territories as early as possible.

By March or April birds will have arrived on their breeding areas of the northern plains, and males soon begin advertising their territories. The birds seek out relatively large areas of thick grasslands, especially low prairies, lightly grazed meadows, and nearly dry marshes with thick edges of emergent vegetation. Less often they choose drier upland prairies or even croplands, but wetter environments are more frequently used than dryland habitats.

With the arrival of females on the breeding grounds, usually a week or more after the males, territorial and courtship interactions begin. There seems to be little or no mate retention from year to year, and at least in some areas there is a slight predominance of females in the adult population, which may be a contributory factor in the tendency toward polygyny exhibited by this species. Males begin territorial advertising and female attraction by performing "sky-dancing," which consists of a series of frequently repeated U-shaped aerial maneuvers, ascending and descending from between 30 and 300 feet above the ground, as the bird tracks over a course of up to a half-mile in linear distance. Some chattering calls may occur at the zenith of each arc. At the end of the flight the male may descend to earth and disappear at a point that may serve to indicate a potential nest location. Interested females will follow the male and perhaps investigate the site themselves. Evidently those males that perform such displays most vigorously are able to attract females most effectively, and such birds may acquire a harem of from two to five females. However, many males acquire but a single mate, and there is also some evidence that subadult yearling males are likely to attract only subadult females. Breeding territory sizes are seemingly highly variable in area, and perhaps

such variation is a reflection of the relative food resources within the territories as well as presumably indicating variations in individual male fitness.

Long-billed Curlew

Easily the most impressive of North America's shorebirds, and the proclaimed favorite bird of Sandhills ranchers, the long-billed curlew is mostly limited to the wet meadows and upland prairies of the western Sandhills and, in decreasing numbers, the shortgrass plains of the Nebraska Panhandle (Mollhoff, 2001).

During late May and early June it is rare to spend a day in the Sandhills without seeing and hearing curlews. At that time of year the incubating or brooding birds are extremely alert to any possible disturbance. They intensively mob any person or other possible threat to their nest or brood with diving calls and raucous screams from nearby dune tops.

Long-billed curlews are especially evident shortly after they arrive in April, when unpaired males perform advertisement flights above their territories. In these so-called soft "kerr, kerr" flights the males rise almost perpendicularly, then set their wings in an umbrella-like manner and glide down, uttering a series of rapid and melodious "kerr" notes. They may almost reach the ground before rising to start another calling and gliding sequence. A quite different aerial display pattern called the "arc flight" is performed when human or other mammalian intruders come near a nest or brood. The threatening bird flies directly toward the intruder, only to veer away at the last moment and begin a high arcing flight that precedes the next approach. A wing-lifting display, exposing the beautiful cinnamon-colored underwing surface, is used by adults during intense threat display, and a similar upright wing fluttering is performed by males just before copulation. Nest-scraping behavior is used during courtship and may result in the choosing of an actual nest site.

Females hide their nests in low cover on the upland Sandhills prairies, often in a clump of grass less than a foot high, or barely enough to cover the incubating bird. Yet they are virtually invisible under those conditions; I have been within ten feet of an incubating female and aware almost exactly of where the nest was located, yet was usually unable to see the bird before it flushed. Often the nest is situated near a shrub, rock, or mound of dirt, which landmark perhaps help the female to locate her own nest.

Curlew clutches are almost invariably of four eggs, and incubation takes four weeks. In the Sandhills, hatching often occurs during the last week in May and the first week of June. All the chicks emerge from their eggs within a period of five hours or so. If they hatch late in the day, they are likely to spend the night in the nest, leaving it early the following morning. The highly mobile chicks are guarded by both adults. After the young are two to three weeks old, the female often abandons her brood, but the male continues to look after them until they fledge at about six weeks of age. Fledging usually occurs before the end of July in the Sandhills, and the birds then undergo an early migration out of the region.

During a study of the curlew in the Sandhills, Gregory (2010) banded two breeding curlews with radio-collars that allowed satellite continuous tracking. One of the two flew from Nebraska to northern Texas in less than 24 hours. The other later took a week to get from Nebraska to southern Texas. Both of them spent the winter on the Gulf Coast of northeastern Mexico.

Forster's Tern

The marshy lakes of the central and western Sandhills are Nebraska's only nesting areas for this beautiful tern. I have seen it nesting most often at Crescent Lake National Wildlife Refuge in Garden County, but there are also confirmed breedings in Cherry and Grant counties (Mollhoff, 2001) and reported breeding in Arthur County (Brown et al., 1996).

Unlike black terns, Forster's terns are almost exclusively fish-eating birds, which means that the generally fish-poor Sandhills are probably not ideal breeding habita. Observations in Minnesota indicated that the fishes presented to mates during courthship included, in descending frequency, yellow perch, shiners, sunfish, and northern pike, whereas among those given to chicks the corresponding frequencies were yellow perch, shiners, and sticklebacks. Those fed to mates av-

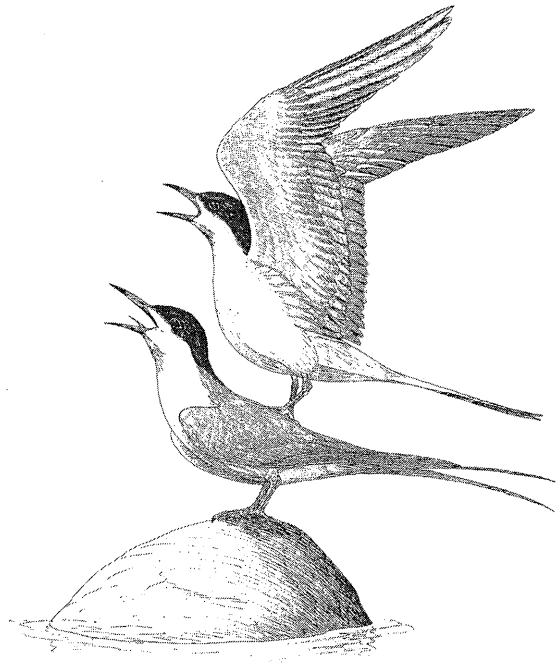
eraged larger than those of fish seined nearby, whereas those fed to chicks increased in size as the chicks grew (McNicholl, Lowther & Hall, 2001).

Courtship in this tern begins or is already underway at the arrival on the breeding grounds, typically between mid-Aptil and mid-May. In one common display, two terns (one carrying a fish) performs a high light, with rapid wingbeats and the wings angled backwards. After reaching a high point, the leading bird then begins a gliding descent, and on landing the fish-carrying individual feeds the other bird. During so-called low flights, the wings are beat quickly, but with low amplitude and while being held high above the back. Often a second bird will join in this flight, and may land with the first, when terrestrial courtship occurs. Land courtship includes a parading of the fish-carrying bird around a presumed female, followed by an exchange of the fish. Incipient nest-building (scraping behavior) may occur during parading, Courtship feeding is not only a part of courtship and precopulatory behavior, but continues through incubation.

Nesting is done colonially, often in groups of from two to about 100 nests, the nests sometimes placed within a few meters of one another. The simple nest may be placed on a raft of floating vegetation or on a muskrat house, and at times the nest material may be soggy, or the eggs may even touch the water.

Two or three eggs constitute the usual clutch, and incubation begins with the first egg. It is performed by both sexes, with frequent nest changeovers. Incubation lasts 24–25 days, with the last egg in two- or three-egg clutches typically hatching two days after the first. The chicks leave their nest at about four days of age, when they are called away by the adults. They are not able to fly until they are about 4–5 weeks old. The age of sexual maturity is still not known with certainty, but is probably at least two years, with breeding thereafter done yearly. The maximum reported longevity of banded birds is 12 years (McNicholl, Lowther & Hall, 2001).

Fig. 21



Forster's tern, pair mating

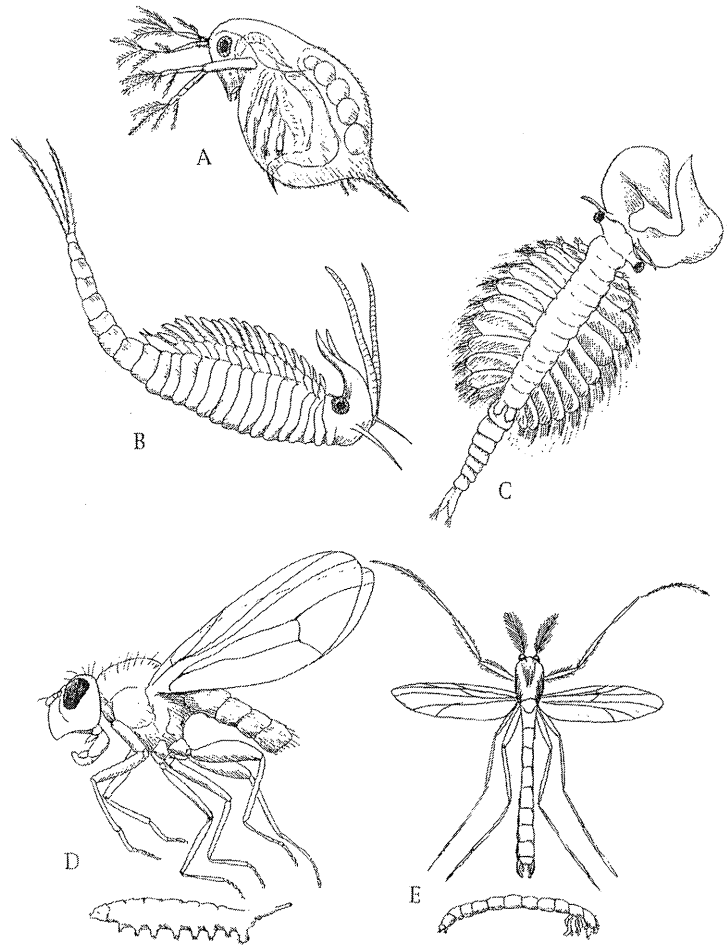
Yellow-headed Blackbird

The yellow-headed blackbird has a broad breeding distribution that is centered in the Sandhills and extends west locally into the Panhandle counties. It also breeds south into the Rainwater Basin, at least during years of plentiful water. This blackbird needs water of sufficient depth as to have areas of open water adjacent to beds of cattails, bulrushes or other emergent plants, with cattails being the most highly preferred substrate for nest supports (Mollhoff, 2001).

More generally, this species is primarily associated with prairie wetland, but prefers deeper water than the red-winged blackbird, where there are stands of cattails, bulrushes, or reeds interspersed with open water. Primarily aquatic prey, mainly insects obtained within the territory if they are abundant, are eaten during the breeding season. These include emerging dragonflies and damselflies, and a variety of beetles, lepidoteran larvae, and dipterans. Males are more prone to forage more widely, often on terrestrial weed or crop seeds.

Territorial males are both visually and acouticially conspicuous, producing two different song types. One is a "buzzing" and distinctly nasal song, lasting up to four seconds, and is directed to other nearby individuals. It is usually accompanied by an asymmetrical song spread display, with the head turned sideways and tilted somewhat. The accenting song is more musical, with several fluid introductory notes, and some-

Fig. 20



Common aquatic invertebrates of Nebraska Sandhills wetlands, including cladoceran water flea Daphnia (A), fairy shrimp (B), brine shrimp (C), adult and larval brine fly (D), and adult and larval midge (E).

times is followed by a variable trill. It is directed toward more distant birds, and is usually accompanied by a symmetrical song spread. The buzzing song is similar among males, but the accented song varies greatly among males as to its length, phrasing and timing (Twedt and Crawford, 1995).

Territorial sizes are varied, according to habtiat quality, and may range in size from less than a hundred to several thousand square yards, and with emergent vegetation covering from 35 to 77 percent of the area. Females maintain small "territories" surrounding the nest site, but ignore male boundaries. Females are evidently not significantly influenced by the male's yellow head plumage, as those males whose heads had been experimentally blackened were able to attract females, defend their boundaries and sometimes were even able to usurp the territories of others.

Typically the number of females is a single "harem" are from one to six. Marshes with higher rates of dragonfly emergence have been reported to have higher female densities and more females per male than less productive marshes. In one study the number of females within a territory was found to be directly related to the among of edge, but inversely proportional to territory size. Yellow-headed blackbirds are larger than red-winged blackbirds, and dominate them in territorial conflicts. They are also highly aggressive toward marsh wrens, although their territories are not mutually exclusive (Twedt and Crawford, 1995).

Males arrive first on breeding areas, and their territories have been established by the time the females arrive. The females' nesting sites are located within the territories of the males. Evidently females will perform precopulatory crouching in response to any males, and will copulate with them when the territorial owner is absent.

Nesting begins as soon as the females arrive at the breeding grounds, with some nests initiated within three days, and in one study the majority of nests had an egg present only one day after the nest was completed. The usual clutch-size is 3-4 eggs, and the incubation period is 12–13 days. Only a single brood is raised per season, but renesting will occur if the first nest is destroyed.

THE CENTRAL AND EASTERN SANDHILLS WETLANDS

The wetlands in the central and eastern parts of the Sandhills tend to be much less alkaline than those in western regions, and support a greater diversity of wetland flora. The diversity and abundance of native fishes is also greater, so it is likely that fish-eating birds such as herons and grebes are more abundant here. However, alkaline-adapted species such as the cinnamon teal, long-billed curlew, Wilson's phalarope, black-necked stilt and American avocet are far less likely to be found in this region.

BROWN COUNTY

(See also Niobrara Valley Region for Niobrara River sites, Chapter 3)

Brown County is a Niobrara Valley and Sandhills county, with about 8,000 acres of surface water. The county's area is 1,221 square miles (averaging 2.8 people per square mile). It contains three state recreation areas, seven wildlife management areas, and its entire northern border is bounded by the Niobrara River, and the headwaters of the Calamus River are located here.

American Game Association Marsh WMA. Area 160 acres. A large Sandhills marsh and surrounding grassland. During wet years at least 120 acres are marshland. Wetland birds include several ducks, great blue heron, black-crowned night-heron, American bittern, sora and Virginia rails (and possibly also the extremely rare yellow and black rails), swamp sparrow, and yellow-headed and red-winged blackbirds. Located one mile east and 19 miles south of Johnson. Lat./Long. 42.3078/-100.06539.

Bobcat WMA. Area 893 acres. Consists of coniferous woods along Plum Creek canyon, and some Sandhills grasslands. Located 12 miles north of Ainsworth. Lat./Long. 42.72726/-99.87732.

Long Lake SRA. Area 80 acres, with 50 acres of wetland. A Sandhills lake and smaller marshes along the headwaters of Calamus River. Located 20 miles south of Johnson. State park entry permit required (Ph. 402/684-2921). Lat./Long. 42.29292/-100.10351.

Long Pine SRA and WMA. Area of SRA 160 acres. Mostly coniferous woods along Long Pine Creek. Located south of U.S. Highway 20, one mile west of Long Pine, State park entry permit required (Ph. 402/684-2921). Lat./Long. 42.54651/-99.7109. Long Pine WMA is located in the same vicinity but lies north of Highway 20, and also has riparian habitats along Long Pine Creek. Lat./Long. 42.55361/-99.70319.

Pine Glen WMA. Area 960 acres. Creekbottom woods, mixed grasslands and wooded canyon habitats. Located seven miles west and 6.5 miles north of Bassett. Lat./Long. 42.67304/-99.69679.

Plum Creek WMA. Area 1,320 acres. Two miles of Plum Creek riparian frontage, and Sandhills prairie. From Johnston drive west 1.5 miles on U.S. Highway 20, then south 1.5 miles via county road. Lat./Long. 42.54543/-100.10433.

School Land WMA & Keller Park SRA. Combined WMA/SRA area 836 acres (WMA 640 acres, SRA 196 acres). Native prairie, wooded canyons, and five fishing ponds (totaling ten acres) near Bone Creek. Located seven miles north and four miles east of Ainsworth (School Land W. M. A), or 12 miles north of U.S. Highway 20 on U.S. 183 (Keller Park S. R. A). State park entry permit required for Keller Park S R. A. (Ph. 402/684-2921; Lat./Long. 42.65846/-99.78476). URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=250

South Pine WMA. Area 420 acres, including 152 acres of marsh. Located 11.5 miles south of Long Pine. Lat./Long. 42.36858/-99.72682.

South Twin Lake WMA. Area 160 acres. A 60-acre Sandhills lake and grasslands. Located 19 miles south and three miles west of Johnson, via a sand road, or 11 miles south of Long Pine. Lat./Long. 42.3137/-100.11954.

Willow Lake (Brown County) WMA. Area 511 acres. A 450-acre Sandhills lake and 61 acres of wet meadows. The Brown County designation distinguishes this site from the Willow Lake in Valentine National Wildlife Refuge, Cherry County. Located 24 miles south

of Johnson. Lat./Long. 42.23678/-100.0813.

CHERRY COUNTY

(see also Niobrara Valley Region for Niobrara River sites, Chapter 3)

Cherry County is a Sandhills and Niobrara Valley county, and mostly consists of Sandhills habitat, with about 41,000 acres of surface wetlands, mostly freshwater marshes plus several some fens. The county's area is 5,718 square miles (averaging 1.0 people per square mile). It contains two national wildlife refuges, one national forest, one state park, one state recreation area, and nine wildlife management areas. Its entire east-west length is crossed by the Niobrara River, and the headwaters of the Snake, North Loup, Middle Loup and Dismal Rivers are all located here.

Ballard's Marsh WMA. Area 1,561 acres. A large Sandhills marsh and adjoining grasslands. Located 18 miles south of Valentine. Lat./Long. 42.59624/-100.54873.

Big Alkali WMA. Area ca. 900 acres. A 842-acre Sandhills lake and adjacent wet meadows. Located 15 miles south and three miles west of Valentine. Lat./Long. 42.63914/-100.60673.

Cottonwood Lake SRA. Area 180 acres. A 60-acre Sandhills lake and adjacent wet meadows. From Merriman drive 0.5 mile east on U.S. Highway 20, and 0.5 mile south. State park entry permit required (Ph. 308/684-3428). Lat./Long. 42.91593/-101.67505. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=53

Cottonwood/Steverson WMA. Area 2,919 acres. Includes three lakes (Cottonwood, Steverson and Home Valley) in the headwaters area of the North Loup River. Steverson Lake (ca. 500 acres) is the largest, while Cottonwood (ca. 230 acres) is the deepest Sandhills Lake, at 20 feet. Home Valley Lake (ca. 200 acres) is the smallest. The western end of Steverson Lake has a fen, with associated cold-climate relict plants, and breeding swamp sparrows. Several other fens also occur in the vicinity (Steinauer, Rolfsmeier, and Hardy, 1996). Located about 28 miles north of Hyannis on State Highway 61. Lat./Long. 42.41736/-101.6975.

Merritt Reservoir SRA. Area 6,147 acres, with 3,000-acre lake. A Sandhills reservoir on the Snake River. Located 28 miles southwest of Valentine on State Highway 97. Adjoins Samuel R. McKenzie National Forest, Park permit required (Ph. 402/376-3320). Lat./Long. 42.60838/-100.89559.

Samuel R. McKenzie National Forest. Area 116,000 acres. Sandhills grasslands planted with 2,200 acres of coniferous forest south of the Niobrara River. The only wetlands are in the Lord Lakes area east of the headquarters. Located 18 miles south of Nenzel via county road S16-F. Address: Samuel R. McKenzie National Forest, 125 N. Main St., Chadron, NE 69337 (Ph. 308/533-2257 or 308/432-0300).

Valentine National Wildlife Refuge. Area 71,516 acres. Nebraska's largest national wildlife refuge, consisting mostly of Sandhills prairie, with sand dunes and intervening interdune depressions that contain many shallow, sometimes lake-sized, marshes. Although not part of the refuge, the road leading west from Hackberry Lake though Kennedy to State Highway 97, then south through Wamaduze Valley to Brownlee, is worth driving for the many small and attractive wetlands visible from the road. The refuge checklist of 272 species includes 100 wetland species, including 31 shorebirds, 24 waterfowl, 10 gulls and terns, 5 grebes and 4 rails. Probable or knownwetland breeders include 11 waterfowl and three grebes. Other notable wetland breeders are the least bittern, white-faced ibis, cattle egret, willet, upland sandpiper, long-billed curlew, black and Forster's terns, marsh wren and swamp sparrow. Free-access prairie-chicken and sharp-tailed grouse blinds are available on a first-come basis. Many of the remote back-country roads on the refuge are recommended only for adventurous persons with a good deal of self-confidence and driving vehicles with four-wheel drive. Located 22

miles south of Valentine (Ph. 402/376-378). URL: http://valentine.fws.gov/

CUSTER COUNTY

Custer County is a Sandhills and Loup River valley county, with about 2,500 acres of surface water, mostly associated with the Loup River Valley. The county's area is 2,576 square miles (averaging 4.4 people per square mile). It contains two state recreation areas, one wildlife management area, and is crossed diagonally by the South and Middle Loup rivers.

Arcadia Diversion Dam WMA. Area 925 acres. Riparian woods along the Middle Loup River. Located 8.5 miles northwest of Arcadia. Lat./Long. 41.49138/-99.23107.

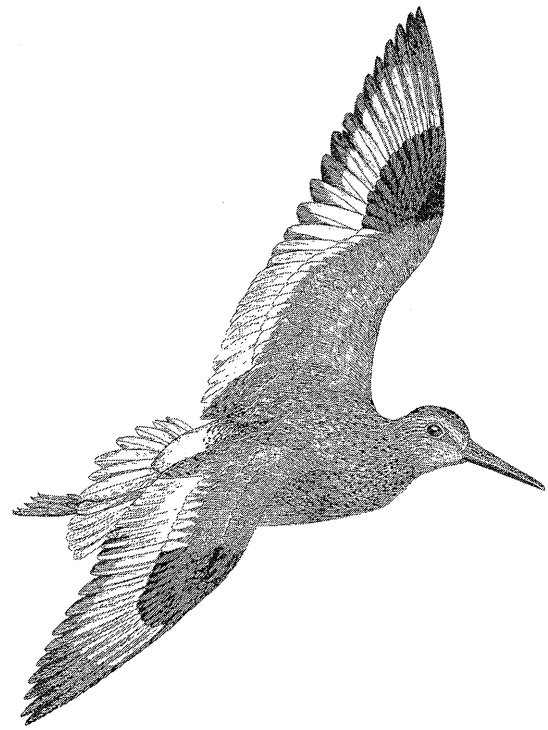
Pressey WMA. Area 1,640 acres. South Loup River valley lowlands, plus hills and steep canyons. Jon Farrar (2004) listed 38 birds as a "sampler" of the area's bird life, of which most are riparian forest species, and some more typical wetland species such as the wood duck, great blue heron and northern harrier. Located five miles north of Oconto. Lat./Long. 41.18373/-99.70866.

GARFIELD COUNTY

Garfield County is a Sandhills county with about 6,000 acres of surface water, nearly all reservoir acreage. The county's area is 570 square miles (averaging 3.2 people per square mile). It contains one state recreation area/wildlife management area, and is crossed diagonally by the Calamus and North Loup rivers.

Calamus Reservoir SRA/WMA. Area 11,370 acres. A 5,123-acre reservoir on the Calamus River, extending into Loup County. This is a favorite foraging area for American white pelicans and double-crested cormorants. The upper end is swamp-like, with submerged and standing snags. Located seven miles northwest of Burwell, on State Highway 96. State park entry permit required (Ph. 308/346-5666). Lat./Long. 41.87433/-99.28328. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=275

GRANT COUNTY



Willet, adult in flight

Grant County is a Sandhills county with about 3,500 acres of surface water. It contains three state wildlife management areas, but has no rivers. The county's area is 776 square miles (averaging 0.8 people per square mile). The Oglala aquifer is over 500 feet deep throughout the entire county, and the tallest dune in the entire Sandhills region (over 400 feet) occurs in northern Grant County.

Avocet Lake WMA. Area ca. 600 acres. A large roadside Sandhills marsh, typically supporting breeding coots, eared grebes and American avocets. Trumpeter swans and black-necked stilts are often seen here. Two miles east of Hyannis (junction of U.S. 2 and State Highway 81.

De Fair Lake WMA. Area ca. 400 acres. A typical Sandhills marsh. Located two miles east of Hyannis and south on State Highway 81 for three miles (east side). Lat./Long. 41.96298/-101.71131.

Frye Lake WMA. Area ca. 600 acres. A typical Sandhills marsh. Located one mile north and 1.5 mile east of Hyannis. Lat./Long. 42.02011/-101.74465. Although not public access, Doc Lake, 12 miles east of Hyannis near Whitman, can be easily observed from U.S. Highway 20. It often has a pair of nesting trumpeter swans, as well as a diversity of waterfowl and other wetland birds.

HOLT COUNTY

Holt County is a Sandhills and Niobrara Valley county with over 12,000 acres of surface water, mostly Sandhills wetlands. The county's area is 2,413 square miles (averaging 4.4 people per square mile). It contains one state recreation area, three wildlife management areas, and its entire northern border is bounded by the Niobrara River.

Atkinson SRA. Area 54 acres, including a 14-acre Elkhorn River reservoir. Located at northwest edge of Atkinson. State park entry permit required (Ph. 402/935-5313). Lat./Long. 42.5386/-99.00032. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=9

Goose Lake WMA. Area 349 acres. A Sandhills lake surrounded by grasslands and wooded uplands. Located four miles west of U.S. Highway 281 and two miles north of the Wheeler County boundary, or 23 miles south and four miles east of O'Neill (Ph. 402/370-3374). Lat./Long. 42.11046/-98.5641.

Redbird WMA. Area 433 acres. Mostly woods along Louse Creek, plus upland grasslands. Located one mile south of U.S. Highway 281 bridge over Niobrara River. Lat./Long. 42.7559/-98.43152.

ROCK COUNTY

Rock County is a Niobrara River valley and Sandhills county with about 11,000 acres of surface water, mostly Sandhills wetlands. The county's area is 1,009 square miles (averaging 1.5 people per square mile). It contains no federal wildlife areas, although the John and Louise Seier National Wildlife Refuge (west of Rose) is under development, and has one state wildlife area. Its entire northern border is bounded by the Niobrara River, and the headwaters of the Elkhorn River are located here.

Hutton Niobrara Ranch Wildlife Sanctuary. Area 4,919 acres, with several miles of Niobrara River frontage. Meadows and pastures at the head of Willow Creek are present, as well as spring-fed streams and wet meadows. No bird list is available yet, but grassland and meadow species such as long-billed curlews, sharp-tailed grouse and bobolinks are among the probable nesters. Two guest houses are available for short stays. Located about 15 miles northeast of Bassett (drive north five miles, east six miles, then north four miles on county roads to reach the Hutton guest house; see Niobrara Sanctuary website for more detailed driving directions). Owned by Audubon of Kansas Ph. 785/537-4385). URL: http://www.audubon-ofkansas.org or http://www.niobrarasanctuary.org.

John and Louise Seier National Wildlife Refuge. Area 23,00 acres. A Sandhills refuge 25 miles south of Bassett. Mostly grassland, with about 400 acres of wetlands. Two small creeks pass through the refuge. Still under development and not yet open to the public.

Twin Lakes (Rock County) WMA. Area 113 acres, including 83 acres of Sandhills lakes. From Bassett drive 15 miles south, three miles east, and three more miles south. Lat./Long. 40.83408/-96.9534.

THOMAS COUNTY

Thomas County is a Sandhills county, with about 1,500 acres of surface water. The county's area is 713 square miles (averaging 0.8 people per square mile). It contains one (artificially planted) national forest, and is crossed by the Middle Loup, Dismal and South Loup rivers. The Oglala aquifer is over 500 feet deep throughout nearly the entire county.

Bessey Ranger District, Nebraska National Forest. Area 90,465 acres. Planted conifers in this planted coniferous forest provide habitat for species as diverse the great horned owl, black-capped chickadee, chipping sparrow and red crossbill. Deciduous riparian thicket areas along the Middle Loup and Dismal rivers attract several woodpeckers, both towhees, brown thrasher and Baltimore oriole. The local bird list exceeds 200 species. Common poorwills can often be heard at night, and sometimes may be seen along roadsides in car headlights, when driving the sandy roads at night. At least four woodland warblers nest here, includ-

ing the yellow and black-and-white warblers, American redstart and ovenbird. The common yellowthroat and yellow-breasted chat are local wetland breeders. Three vireos (Bell's, warbling and red-eyed) also nest here. Jon Farrar (2004) listed 65 birds as a "sampler" of the area's bird life, nearly all of which are grassland, forest and forest-edge species, as well as a few typical wetland species such as the great blue heron and belted kingfisher. Prairie-chicken and sharp-tailed grouse blinds are available for first-come, first-served public use (the sharp-tailed grouse blind is usually better). Located two miles west of Halsey on State Highway 2, then south on Spur 86B. Address: Bessey Ranger District, U.S. Forest Service, P.O. Box 38, Halsey, NE 691142 (Ph. 308/533-2257). URL: http://www.fs.fed.us/r2/nebraska/units/brd/brd.html

WHEELER COUNTY

Wheeler County is an eastern Sandhills county, with 1,300 acres of surface water. The county's area is 575 square miles (averaging 1.4 people per square mile). It contains one state recreation area, and is crossed diagonally by Beaver Creek.

Pibel Lake SRA. Area 72 acres, including a 45-acre Sandhills lake. Located seven miles east and two miles south of Erickson. State park entry permit required (Ph. 308/346-5666). Lat./Long. 41.75817/-98.53155. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=138

THE LOUP/PLATTE SANDHILLS WETLANDS

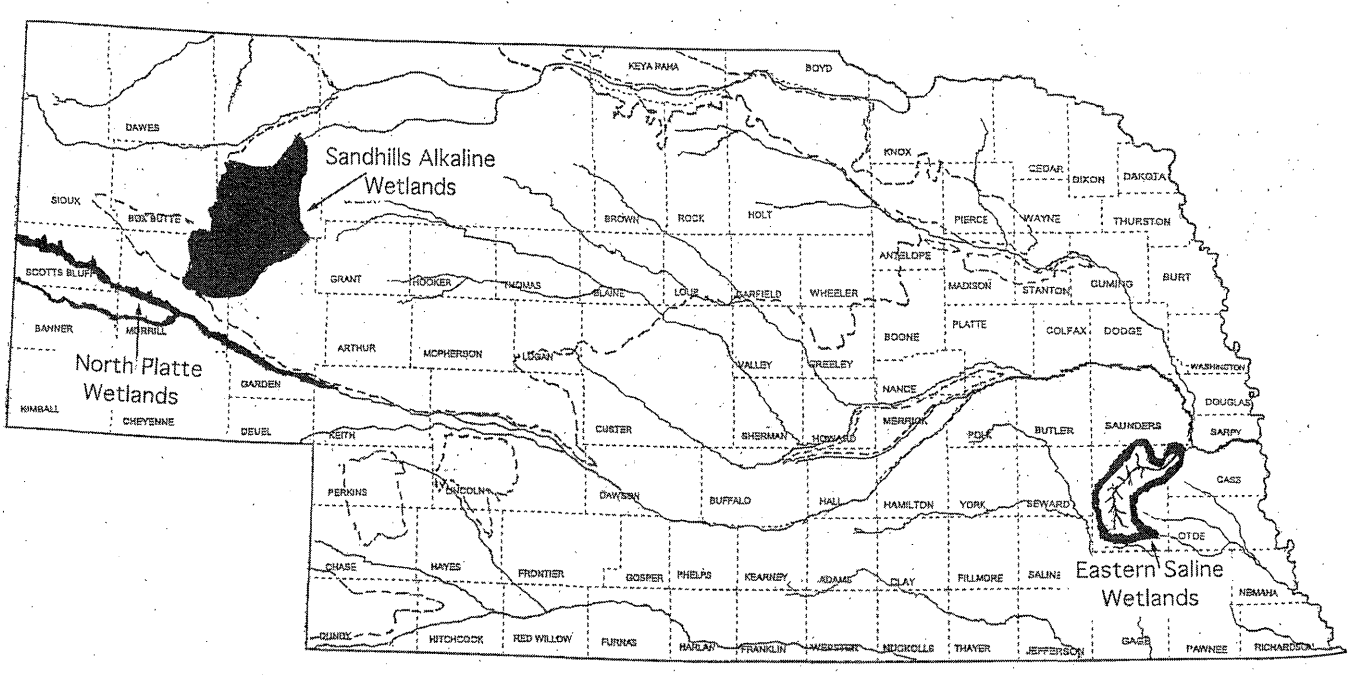
Between the Loup and central Platte rivers a narrow strip of isolated Sandhills topography extends from eastern Buffalo County to eastern Platte County, which is most conspicuously present in Merrick County. Wetlands in this region have been extensively destroyed or drained, and are now are largely limited to a 70-square-mile area south of Genoa. These are mostly small sites averaging less than five acres, and vary from temporary ponds to semi-permanent wetlands (LaGrange, 2005).

MERRICK COUNTY

Merrick County is a Platte River valley county, with about 600 acres of surface water. The county's area is 485 square miles (averaging 16.7 people per square mile). It its entire east-west width is bounded on the south by the Platte River.

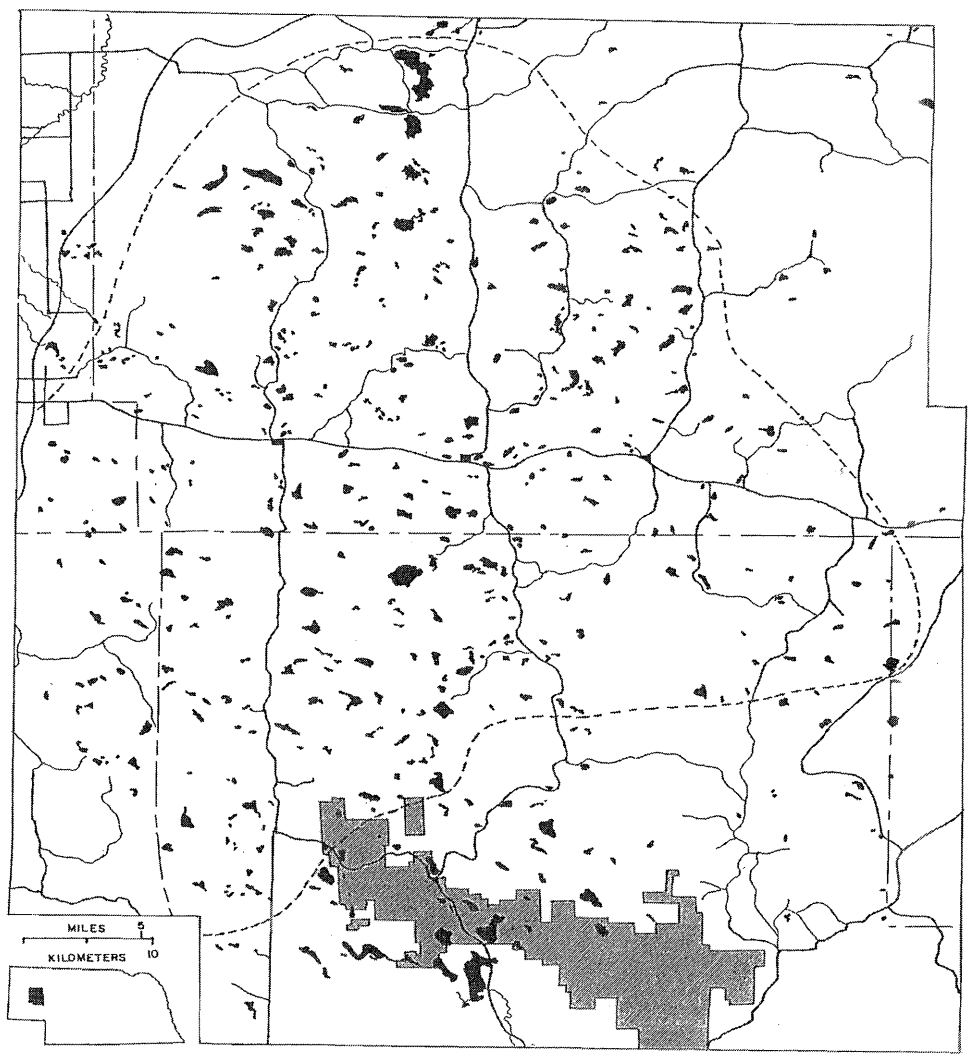
Sunny Hollow WMA. Area 169 acres. Located four miles south and one mile west of Genoa. Lat./Long. 41.37685/-97.73845.

Map 5



Distribution of Sandhills wetlands, North Platte valley wetlands, and eastern saline wetlands. (inked). Map by author, adapted from LaGrange (2005).

Map 6



Locations of individual alkaline wetlands (inked) in the western Sandhills region (northern Garden County and southern Sheridan County). The dashed line represents the limits of the most highly alkaline wetlands, and the shaded area indicates Crescent Lake National Wildlife Refuge. Map by author, from Johnsgard (1995).

THE WESTERN ALKALINE SANDHILLS WETLANDS

This remarkable region in the Sandhills is notable for the high levels of alkalinity that are found in its numerous wetlands. About 85 percent of the Sandhill region's hyperalkaline wetlands are located in Sheridan, northern Garden and northeastern Morrill counties. For example, Sand Lake in Garden County was once reported to have a salt concentration of 136,000 milligrams/liter!

The heart of the hyperalkaline wetlands region centers around Antioch, a nearly abandoned settlement about 15 miles east of Alliance, and the wetlands are rich in sodium and potassium carbonates. Potash Lake is a hyperalkaline wetland located at the eastern edge of Antioch, and many other salt-rimmed wetlands are visible along the county road north of Antioch. These vegetation-free wetlands often attract American avocets, phalaropes, black-necked stilts and other shorebirds. Similar hyperalkaline wetlands may be seen from Antioch east to Lakeside, where a large wetland is located along State Highway 250 at the northeast edge of town. This highway south of Lakeside extends within the alkaline lake region to Crescent Lake National Wildlife Refuge. North from Lakeside via State Highway 250, the variably alkaline wetland region extends for about 20 miles, and the same is true along State Highway 27 going north from Ellsworth. All these wetlands are located on private property but many can be observed from public roadsides.

Fig. 23

Western grebes, pair performing water dance

MORRILL COUNTY

Morrill County is a North Platte valley and high plains county, with almost 5,000 acres of surface water. The county's area is 1,424 square miles (averaging 3.6 people per square mile). It contains one state recreation area, one wildlife management area, and its entire east-west width is crossed by the North Platte River.

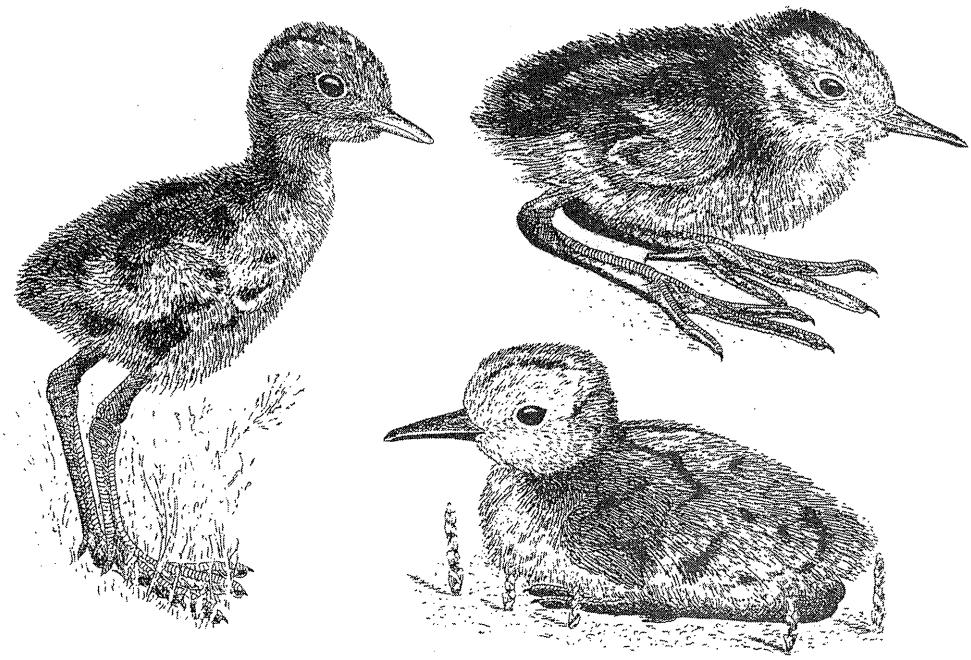
Chet & Jane Fleisbach WMA (previously known as Facus Springs WMA). Area 422 acres. This wetland site east of Chimney Rock National Monument is one of the few remaining alkaline marshes in the North Platte Valley. Sandhill cranes have bred here repeatedly in recent years. Other known or probable wetland nesters include the cinnamon teal, American avocet, Wilson's phalarope and Wilson's snipe. Located two miles south and three miles east of Bayard. Lat./Long. 41.6922/-103.26333.

GARDEN COUNTY

(See also North Platte Valley Wetlands, Chapter 4)

Garden County is a Sandhills county, with over 22,000 acres of surface water, mostly consisting of freshwater or alkaline Sandhills wetlands. The county's area is 1705 square miles (averaging 1.2 people per square mile). Northern Garden County, south to Crescent Lake National Wildlife Refuge, is the geographic center of the Sandhills' alkaline to hyperalkaline wetland region. The county contains one national wildlife refuge, one wildlife management area, and its entire east-west width is crossed by the North Platte River.

Crescent Lake National Wildlife Refuge. Area 45,818 acres. There are about 20



Chicks of upland sandpiper (left), Wilson's phalarope (upper right) and long-billed curlew (lower right).

wetland complexes on this enormous Sandhills refuge; the wetlands total 8,251 acres, and comprise almost 20 percent of the refuge. The refuge bird list includes 273 species, with many wetland species. At least 32 species of waterfowl have been reported here, and 14 are known or suspected breeders. Three grebes (western, eared and pied-billed) are also breeders. Other wetland breeders include the double-crested cormorant, great blue heron, black-crowned night-heron, sora and Virginia rails, and black and Forster's terns. The common yellowthroat and sedge and marsh wrens are abundant, and both the white-faced ibis and black-necked stilt established early state nesting records here and now breed regularly. The marshes and shallow lakes in this large and remote refuge vary greatly as to their relative alkalinity. Border Lake at the western edge of the refuge marks the eastern boundary of hypersaline water conditions; the Wilson's phalarope and American avocet are common breeders here. Located 28 miles north of Oshkosh; no gas station or accommodations are closer (Ph. 308/635-785l or 308/762-4893). URL: http://www.lpsnrd.org. http://crescentlake.fws.gov/

SHERIDAN COUNTY

Sheridan County is a northern Panhandle county with over 20,000 acres of surface wetlands, much of which consists of reservoirs and highly alkaline Sandhills marshes. The county's area is 2,441 square miles (averaging 2.3 people per square mile). It contains one state recreation area, two wildlife management areas, and its entire east-west width is crossed diagonally by the Niobrara River.

Smith Lake WMA. Area 640 acres. A 222-acre Sandhills lake, surrounded by cattail marsh, wet meadows, grasslands, and woods. This lake was well described (under the fictitious name "Pine Lake") by Stephen Jones in his book The Last Prairie – A Sandhills Journal. He observed 145 bird species there, including 51 probable or possible breeders. Known wetland breeders include the wood duck, ruddy duck, northern harrier, long-billed curlew, swamp sparrow, and bobolink. The marbled godwit is also a rare or perhaps occasional nester here. Jon Farrar (2004) listed 40 birds as a "sampler" of the area's bird life, of which 18 are typical wetland species such as the bald eagle, piping plo-

ver and spotted sandpiper. Many other attractive but privately owned and increasingly alkaline wetlands may be seen farther south along State Highway 260 in Sheridan and Garden counties. Located 21 miles south of Rushville. Lat./Long. 42.40563/-102.45414.

Walgren Lake SRA. Area 130 acres. A 50-acre impoundment in an otherwise poorly watered region, which includes open water, wet meadows and uplands. Located three miles south and two miles east of Hay Springs. State park entry permit required (Ph. 308/763-2940). Lat./Long. 42.63765/-102.62868.

Chapter 7

The Playa Wetlands Regions

The area of central Nebraska lying south of the Platte River is blanketed by a thick layer of windblown silt, technically called loess. The loess deposits of Nebraska are of several ages. The oldest deposits in Nebraska are those of the Loveland loess, deposited 135,000 to 140,000 years ago. These last-named loess deposits are the most extensive in Nebraska, and are typically distinctively colored yellowish to reddish brown. A younger loess deposit, called the Gilman Canyon loess, was deposited 24,000 to 40,000 years ago. The youngest deposits, called the Peoria loess, are from 13,000 to 23,000 years old, and may locally be up to 120 feet thick (Maher, Engelmann and Shuster, 20043).

Radiocarbon dating in the loess deposits of the Rainwater Basin indicates that its wetland basins were formed 20,000–25,000 years ago during a relatively arid period, but may have been enlarged 5,000–7000 years ago, and again 3,000–4,000 years ago (Farrar, 1996). When exposed to strong winds, excavations are gradually formed in loess that may eventually fill with water. Over time, the lower layers of silt are increasingly composed of clay as a result of the downward movement of clay-sized particles, and drainage is increasingly impeded. Temporary to semi-permanent wetlands then may develop, as a result of seasonal rains and accumulations of winter snow.

Altogether, the Rainwater Basin encompasses about 4,200 square miles in 17 south-central Nebraska counties. Historically, there were more than 4,000 wetlands in the basin, covering 100,000 acres. Drainage and other factors have reduced the wetland number to fewer than 400, and the total wetland area to as little as about 21,000 acres (Farrar, 1996) or perhaps as much as 34,000 acres (LaGrange 2005).

Additionally, there are some playa wetlands (the Southwest Playa wetlands) broadly scattered over several southwestern Nebraska counties, and amounting to about 21,000 acres of temporary wetlands (LaGrange 2005). The Southwest Playa Wetlands) extend from the Wyoming and Colorado borders east to Lincoln and western Custer counties (Cariveau, Johnson and Sparks. 2007; Cariveau and Pavlacky, 2009). Wetlands in this climatically arid region are even more ephemeral than are those of the more easterly basins, but often support large numbers of migrant birds during spring (Table 12). At least a large part of the attraction of the region to shorebirds and other birds dependent on aquatic invertebrates is the large and diverse populations of these groups in the playa wetlands (Table 13).

There is also a relatively isolated cluster of playa wetlands north of the Platte River and centered just south of the Sandhills in Custer, Valley and Buffalo counties (the Central Table playas), with about 7,000 acres of wetlands (LaGrange 2005). Lastly, there are the remnants of a playa wetland complex in east-central Nebraska, where loess deposits have covered some paleovalleys formed by the Platte River during late Pleistocene times (the Todd Valley playas), and covering about 2,600 acres (LaGrange 2005).

Natural History Profiles of Some Playa Wetland Species

Black-necked Stilt

A near relative of the American avocet, the black-necked stilt similarly favors alkaline lakes and marshes. During the Breeding Bird Atlas surveys of the 1980s, only two confirmed breeding locations were obtained, from northern Garden (Crescent Lake National Wildlife Refuge, in 1985 and 1987) and southern Sheridan counties (Mollhoff, 2001). Since that time its Nebraska population has expanded, and from its initial nestings there have breedings in Sheridan County, where a colony was established in 1987 at an alkaline

Table 12

Twenty Most Abundant Bird Species in Southwestern Nebraska Playa Wetlands, 2006–8*

Species (total seen)

Snow Goose, 37,208
Mallard, 26,824
Blue-winged Teal, 4,333
Northern Pintail, 9,764
Green-winged Teal, 8,558
Pied-billed Grebe, 108
Double-crested Cormorant, 123
American Coot, 2,692
Sandhill Crane, 607
Killdeer, 3,108
Yellow-headed Blackbird, 1,153
Lesser Yellowlegs, 767
Baird's Sandpiper, 631
Wilson's Snipe, 336
Wilson's Phalarope, 1,853
Black Tern, 136
Horned Lark, 4,115
Barn Swallow, 1,106
American Pipit, 1,207
Red-winged Blackbird, 3,094

*Data of Cariveau & Paviacky (2009), based on 9,362 visits to 558 sites. Arranged in taxonomic order. A total of 140 species were seen, including 20 species of waterfowl, 20 shorebirds, 14 waterbirds, 9 wetland-dependent birds, and 81 landbirds. Playas reported by county, 2006-2006 by Cariveau & Paviacky included 80 in Keith, 73 in Kimball, 58 in Chase, 16 in Cheyenne, 14 in Deuell, 5 in Lincoln, 2 in Dundy, 1 in Banner and none in Hayes.

marsh between Lakeside and Antioch (Sharpe, Silcock and Jorgensen, 2001). These and other local Sandhills breedings have since continued.

Like avocets, black-necked stilts favor salt ponds, shallow inland wetlands, and evaporation ponds while on migration, but favor fresher waters, with emergent vegetation such as cattails, bulrushes and sedges for breeding. They often nest on short vegetational cover over water, and on dikes, islands or other high spots with sparse alkali-tolerant vegetation, such as saltgrass and saltwort (Robinson et al., 1999).

Stilts are distinctly territorial, even outside the breeding season. During the breeding season territories are maintained around nest sites. Like avocets, stilts are monogamous, with the pair bond being formed by persistent association of the female with a male, until she is tolerated. The behavior associated with copulation is also very similar to that of avocets, in that the male performs extensive breast-preening and water-splashing before the soliciting female. Likewise, following copulation the two birds briefly stand side by side with their bills crossed, then run forward a short distance. Both species perform very conspicuous distraction displays when their nest or brood is threatened, including both terrestrial and aerial actions. (Hamilton, 1975).

Nest sites of stilts are sometimes close together in suitable habitat, but this may be a reflection of the habitat rather than sociality. At times avocet nests may occur in the same area, but stilt nests are less clumped than avocet nests. The

nest site is selected jointly by the pair, and consists of s simple scrape on a soft substrate. It might be somewhat elevated above its surroundings, and often is placed in low vegetation, such as among grass clumps (Robinson et al., 1999).

The usual clutch is of four eggs, laid on a daily basis. Incubation is performed by both sexes, and typically lasts 25-26 days, with a few days of variation reported outside these durations. The newly hatched chicks leave the nest within 24 hours after the hatching of the last chick, and they may begin to make short, hopping flights as early as 22 days of age. By 27--31 days after hatching more sustained flights can be performed (Robinson et al., 1999).

American Avocet

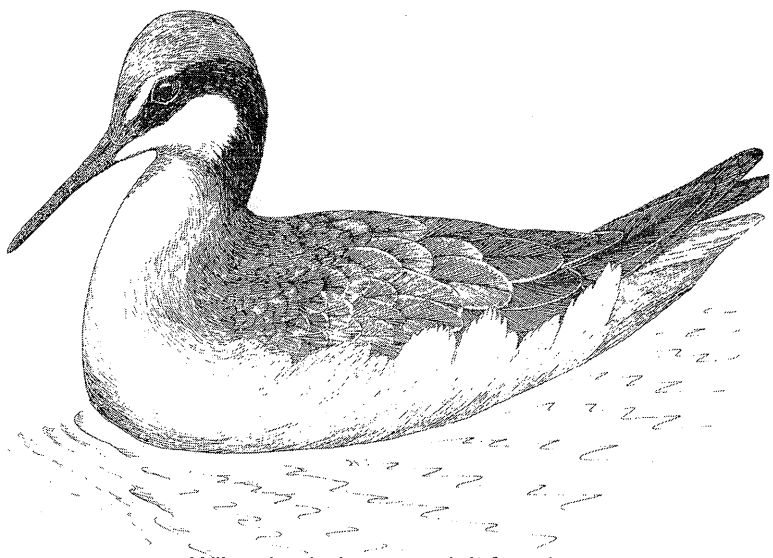
American avocets are among the most graceful of all North American shorebirds, and the only species having an upturned (recurved) bill, which is the basis for their generic name Recurvirostra. Its Nebraska breeding range is almost entirely limited to the southwestern Sandhills, in the alkali lakes area of Garden, Morrill, Dawes and Sheridan counties. There is also occasional breeding in the Rainwater Basin, from Kearney to Fillmore counties (Mollhoff, 2001), and in the alkaline playa wetlands of the North Platte Valley. More generally, it inhabits salt ponds, evaporation ponds shallow playa lakes, mudflats of inland lakes and shallow impoundments. Typically it forages in open water less than ten inches deep that can be waded, but it can also swim when needed. Nesting is done on islands and dikes with the least vegetation (Robinson et al., 1997).

Males have shorter and less recurved beaks than do females, but possible adaptively related sexual differences in foraging or other food-getting behavior have not been noted. In one study it was noted that males spent more time swimming while foraging than did females, and another observer noted that males tend to forage more by plunging the head and upper breast into the water. Females more often used quick pecking jabs of the beak without submerging the head. These methods involve visual hunting techniques. Both sexes mainly forage by using scything-like lateral movements, with the beak submerged. Scything movements are used to capture organisms in the water column, such as small fish (Robinson et al., 1997), and probably rely largely on tactile hunting techniques. In inland saline wetlands brine shrimp, brine flies and fairly shrimp are important food items.

Pairing is monogamous, with bonding occurring when a female persistently associates with a male and is tolerated. No special courtship displays have been described, but precopulatory behavior is elaborate, and involves much breast-preening, bill-shaking and associated water-splashing on the part of the male. The postcopulatory display is equally complex, with the pair briefly standing side-by side with necks extended and beaks touching, then both quickly running forward for up to about eight yards (Hamilton, 1975). Pairs copulate throughout the pre-nesting period, which may help to strengthen the pair bond (Robinson et al., 1997).

In Nebraska, avocets have most often been found nesting in small colonies of from 2–20 pairs, and on shallow alkaline lakes and ponds with broad and gently sloping barren shorelines (Mollhoff, 2001). The clutch-size is three to four eggs, usually four. Eggs are laid daily, so a four-egg clutch is completed in 4-5 days. Incubation usually lasts 24-25 days, with both sexes participating. The chicks are precocial, and when hatching is spread out over several days one parent assumes the care of the hatched young, while the other continues incubation. The young fledge in 4–5 weeks, and are independent by six weeks of age (Robinson et al., 1997.

Fig. 25



Wilson's phalarope, adult female

Wilson's Phalarope

Nebraska represents one of the southernmost breeding regions for the Wilson's phalarope, with nesting concentrated in the Sandhills, but extending south into the Rainwater Basin and western playas during wet springs. Confirmed breeding records were widely scattered during the Breeding Bird Atlas project, but the largest numbers of probable or confirmed records came from Cherry County (seven), Sheridan County (five) Grant County (four) and Garden County (four). Probable breedings in the Rainwater Basin were from Gosper, Kearney and Fillmore counties (Mollhoff, 2001).

The Wilson's phalarope was first discovered on its South American wintering grounds in 1819, not on its Great Plains breeding grounds. All three of the phalaropes are north-temperate to high-Arctic breeders, but all also undergo long, sometimes transequatorial, migrations. The three species also have partially webbed feet, but the Wilson's has the longest toes and the least amount of webbing between them. This adaptation seems to serve Wilson's phalaropes equally well on land, in small wetlands, and even on the open ocean, where few other shorebirds venture. The Wilson's phalarope also has the longest and most delicate bill, and like the two others it feeds mostly while swimming rather than while wading. It delicately touches the tip of its bill to the water's surface, thus letting capillary action draw tiny, plankton-sized organisms into its mouth.

Like the other phalaropes, the Wilson's engages in long-distance, transequatorial migrations. The other two species are likely to spend their nonbreeding periods in pelagic environments, but the Wilson's heads for Andean saline lakes in the high, cold and arid Peruvian, Bolivian, and northern Chilean and Argentine altiplano, a tundra-like environment not far below the permanent snowline. Probably it feeds there in much the same way, and on the same kinds of nearly microscopic foods, as it does in North America. Before undertaking this long fall migration the birds congregate after breeding on hypersaline lakes of the American West, where they undergo their postbreeding molt and take on fat. From there the adults apparently take a nonstop, overseas route above the Pacific Ocean. Juveniles evidently take an over land route southward through Mexico and Central America to South America.

The return migration to the North American breeding grounds is also overland, although it is possible that first-year birds oversummer in South America, since they don't breed until their second year. It is seemingly fairly common for shorebirds that migrate transequatorially to remain in the southern hemisphere through their first year of life. The spring migration northward moves forward through the central plains, with areas such as the Cheyenne Bottoms wetlands receiving massive numbers of birds. Similar shallow, alkaline wetlands of the western Nebraska Sandhills are also heavily used. The majority continue onward to nest in the northern plains states and prairie provinces.

The Wilson's phalarope, uniquely among the species considered in this book, is remarkable in that it has been proven to exhibit sequential polyandry. Like the world's other two phalaropes, it exhibits all the traits one would expect in a polyandrous species. These include reversed sexual dimor-

phism (females are both larger and, in breeding plumage, more brightly patterned than males), female establishment of territory and subsequent advertising for male mates, and total male care of the eggs and chicks. The removal of female responsibility from all parental duties sets the ecological stage for potential polyandry, and the fairly long breeding season in the northern plains provides enough time to find, mate with, and relinquish a second clutch to another willing male.

Phalaropes arrive on their breeding grounds of the central and northern plains in late April or early May. At Crescent Lake National Wildlife Refuge in western Nebraska they quickly congregate at a single hyperalkaline lake, Border Lake, while often ignoring other nearby and relatively freshwater habitats (Bomberger, 1982). Brine flies are abundant at that lake, and probably little else is consumed, judging from personal observations. In other locations brine shrimp are also eaten regularly, but there is little diversity otherwise in their diets.

Females quickly begin courtship activities, but no exclusive territories are established, and the birds remain quite gregarious throughout the breeding season. Low, growling wa notes that seem to function as courtship calls are commonly uttered at this time by females; these notes carry rather far in spite of their low amplitude. Females extend their necks vertically when calling thus, either while in flight or on the ground presumably to increase resonance capabilities of low-frequency sound components. Other calls of even lower average frequency are also produced. A low-pitched and froglike chug call is uttered by females when they are close to males. Pair-forming behavior begins during spring migration, and courtship continues through the nesting period. Females may pursue the males in aerial chases and also will defend males that they have diverted from the attentions of other females. Once pair bonds have been established the birds may remain closely associated, with either sex following the other.

Copulation behavior may be initiated by either sex but most frequently is started by females. It can occur in shallow water, in water of swimming depth, or on dry land. Pair-bonding is of rather short duration, lasting some seven to ten days from initial pairing to the completion of a clutch of four eggs. Then, the female will desert her male almost immediately, or up to two weeks thereafter, and begin to court other males. However, once the male begins incubating her clutch, she may defend him from the attention of other females. There is no evidence that females ever participate in either incubation or brooding behavior.

Females lay their eggs at the rate of one per day, in a nest scrape that they presumably select but which is lined with grasses by the male over the egg-laying period. Sites are selected that are in relatively tall and dense vegetation and usually fairly close to water. Because of the thickness of cover selected, nests are difficult for humans to locate. The almost invariable clutch size is of four eggs, but occasionally larger clutches have been found, certainly the work of more than one female. Incubation by the male usually begins with the laying of the penultimate egg and requires an average of 23 days. The levels of prolactin, a hormone typically associated with parental care, is higher among males than females, and is highest during incubation, with its levels being influenced by the absence of eggs or presence of young (Colwell and Jehl, 1994).

The chicks are as precocial as those of other shorebirds. They are able to swim almost immediately after emergence from the egg, and are tended exclusively by the male. Their fledging period is still unreported, but in the other phalaropes lasts from 18–21 days. Females are prone to acquire a new mate and renest soon after deserting their initial mate. An estimated 22 to 43 percent of females in Saskatchewan were believed to breed at least a second time. Some females were found to produce as many as four clutches, with intervals of only a few days between them. In a Saskatchewan study it was found that the average interval between pair formation and clutch completion was only eight days, with about half the females deserting their mates upon completing the clutch. Some females there were found to produce four clutches in rapid succession. The majority of females (75–79 percent) obtained a single mate, 14-21 percent did not acquire mates, and only 0–11 percent obtained two mates (Colwell and Jehl, 1994).

White-faced Ibis

Although still a rare breeding species in Nebraska, the white-faced ibis was first found nesting in the Rainwater Basin of Clay County, in 1916. The next breeding record was for 1984, at Valentine National Wildlife Refuge, Cherry County, in 1984. The birds nested at Crescent Lake National Wildlife Refuge in 1987, and again in 1998. Although no nesting has yet been documented in the Rainwater Basin, the birds have been reported there during summer more often than anywhere else in the state (Sharpe, Silcock and Jorgensen, 2001), occurring regularly east to the marshes of York and Seward counties (personal observations).

White-faced ibises are generalist foragers, mainly taking aquatic and moist-soil insects, crustaceans and earthworms. Among larval insects, they mainly consume members of the orders Orthoptera, Odonata, Hemiptera, Coleoptera and Diptera, and they also eat leeches and snails. Foraging on land is done visually or with tactile probing. When feeding in water, the bird may move back and forth, probing in the water like a dowitcher, or may stand in place, swinging its bill from side to side (Ryder and Manry, 1994).

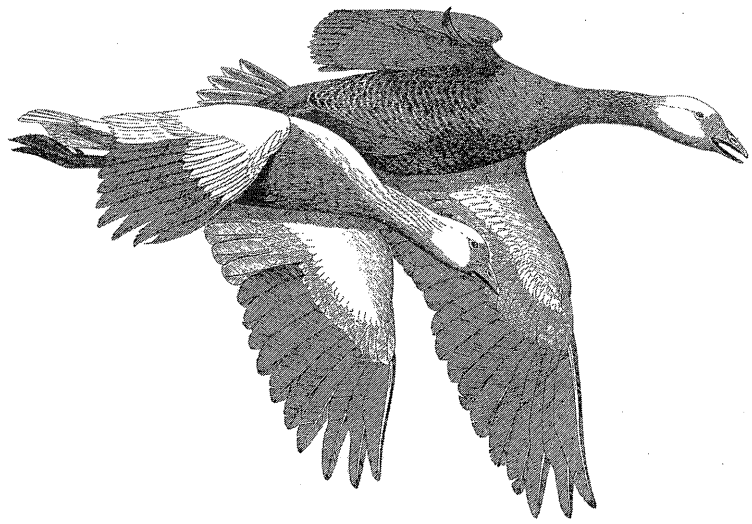
Vocalizations are not well developed in this species, with the loudest being nasal honking calls, uttered during feeding or while in flight. Individuals defend individual space areas immediately around their nest site, but evidently do not defend fixed territories. The birds forage in flocks and communally. Nesting is also done colonially, with distances between nests in high-density sites of about six to 20 feet. The mating system is still only poorly known, but monogamy is assumed. Pair-forming displays are likewise little known, but mutual preening and mutual wagging of nesting materials while both birds hold them in their bills have been seen (Ryder and Manry, 1994).

In the central and northern Great Plains the birds are fairly late nesters, with egg dates from Wyoming and the Dakotas ranging from June 4 to July 25. Two Nebraska nest with eggs were found on June 4 and June 22 (Mollhoff, 2001). Nests are typically placed among emergent vegetation in shallow water, often in stands of cattails or bulrush. Eggs are usually laid every other day, with clutches being completed in 5-8 days. Both pair members incubate. Incubation may last from 20-26 days, depending on the stage in the egg-laying process at which incubation began; eggs laid early in the clutch thus may have substantially longer incubation periods than those deposited later.

The newly hatched young are altricial, and are fed by parental regurgitation. By the time they are three weeks old they may begin to walks about on floating vegetation and explore their surroundings. By late in the fourth week they may begin to make short flights (Ryder and Manry, 1994).

The population in Nebraska seems to be making slow but steady growth, and appears to be a permanent addition to our avifauna.

Fig. 27



Lesser snow goose, white and blue morphs

THE RAINWATER BASIN PLAYA REGION

Many of the seasonal wetlands in this region south of the Platte River are federally-owned waterfowl production areas, or state-owned wildlife management areas supporting shallow playas (locally called "lagoons") that are usually dry by early summer. The 61 waterfowl production areas in the Rainwater Basin totaling (including upland portions) about 23,800 acres (range, 38–1,989 acres) and the 30 wildlife management areas total about 6,000 acres, nearly 4,000 acres of which consist of seasonal wetlands. The Rainwater basin wetlands are highly attractive to migrating waterfowl and shorebirds, in part because of their large populations of aquatic invertebrates, which become available to spring migratory birds at a time when they need protein to ready their bodies for the stresses of reproduction (Table 13).

The region is geographically divided into the western Rainwater Basin, which extends from Frontier and Dawson counties east to western Adams county, and the eastern Rainwater Basin, which extends from eastern Adams County east to Butler, Seward and Saline counties.

Jon Farrar (2004) listed 50 bird species as a "sampler" of the Rainwater Basin's bird life, of which all but four are wetland-dependent forms, especially shorebirds. The region has historically been one of the continent's major staging areas for greater white-fronted geese, but more recently snow geese have largely eclipsed white-fronted geese in sheer numbers. Cackling geese have been appearing in large numbers since they were first distinguished in the early 2000's as a species separate from the larger Canada geese.

Among shorebirds, the buff-breasted sandpiper has its most important spring staging area in the eastern Rainwater Basin, and it is an important spring stopover area for dozens of other shorebirds, perhaps totaling 200,000–300,000 birds (LaGrange, 2005). Jorgensen (2004) estimated that based on his spring surveys of the eastern basin the most common migrants consisted, in descending abundance, of the white-rumped sandpiper, Wilson's phalarope, long-billed dowitcher, stilt sandpiper and Baird's sandpiper. The pectoral sandpiper, long-billed dowitcher, lesser yellowlegs, least sandpiper and stilt sandpiper were most common during fall.

The Rainwater Basin Joint Venture coordinates the basin's wetland management. Its purpose is to protect, restore and create 25,000 additional acres of wetlands, and another 25,000 acres of adjoining uplands. These projected 50,000 acres represent only about two percent of the 17-county Rainwater basin region of 2.69 million acres (Farrar, 19960). The Joint Venture's address is 2550 N. Diers Ave., Suite L., Grand Island, NE 68803 (Ph. 308/382-8112).

The address for the Fish and Wildlife Service's Rainwater Basin Wetland Management District is: U.S. Fish and Wildlife Service, 2610 Ave. Q, P. O. Box 1686, Kearney, NE 68847 (Ph. 308/236-5015). Another useful contact is the Kearney office of the Nebraska Game & Parks Commission, 1617 1st. Ave., Kearney 68847 (Ph. 308/865-5310). Nebraska's playa lakes in the Panhandle region are included within the multi-state Playa Lakes Joint Venture program. Its address is 103 East Simpson St., LaFayette, CO 80026 (Ph. 303/926-0777).

THE EASTERN RAINWATER BASIN

ADAMS COUNTY

Adams County is a Rainwater Basin and loess plains county, with about 900 acres of surface water. The county's area is 563 square miles (averaging 59.5 people per square mile). It contains two waterfowl production areas and one state recreation area. Almost its entire east-west width is crossed by the Little Blue River.

Kenesaw WPA. Area 161 acres of seasonal wetland and 70 upland acres. Located 0.5 mile east and 0.5 mile south of Kenesaw. Lat./Long. 40.602/-98.645.

Weseman WPA. Area 80 acres of seasonal wetland and 80 upland acres. Located nine miles west and four miles south of Hastings, or 0.25 mile west of Assumption. Lat./Long. 42.75643/-97.09508.

CLAY COUNTY

Clay County is an eastern Rainwater Basin and loess plains county, with over 4,000 acres of surface water. The county's area is 572 square miles (averaging 11.7 people per square mile). It contains 15 waterfowl production areas and six wildlife management areas. Its width is crossed by the West Fork of the Big Blue River. Nearly all of the sites listed below are playas that vary greatly as to size and seasonal permanence, depending on recent precipitation.

Bluewing WMA. 160 acres of mixed seasonal wetlands and upland. Located four miles west and 0.5 mile south of Edgar. Lat./Long. 40.36524/-98.04227.

Bulrush WMA. 160 acres of mixed wetland and upland. Located 3.5 miles west of Edgar. Lat./Long. 40.39223/-98.07566.

Eckhardt WPA. Area 66 acres of seasonal wetland and 108 upland acres, including some native prairie. Located eight miles east and four miles south of Clay Center. From Ong, drive one mile north, three miles west and 2.5 miles north. Lat./Long 40.465/-99.903.

Harms WPA. Area 33 acres of seasonal wetland and 27 upland acres. Located two miles east and 2.5 miles south of Clay Center. Lat./Long. 49.48972/-98.00972.

Glenvil WPA. Area 83 acres of seasonal wetland and 37 upland acres. Located 1.5 mile east and 1.5 mile south of Glenvil. Lat./Long. 40.475/-98.22.

Green Acres WPA. Area 48 acres of seasonal wetland and 915 upland acres. Located six miles east and four miles south of Clay Center, or 1.5 miles east and 6.5 miles north of Edgar. Lat./Long. 40.46/-97.938.

Green Wing WMA. Area 53 acres of seasonal wetland and 27 upland acres. Located 0.5 mile east and three miles north of Ong. Lat./Long. 40.44298/-97.82895.

Greenhead WMA. Area 60 acres, including a borrow-pit wetland and marsh. Located six miles east and six miles south of Clay Center, or 1.5 miles east and 4.5 miles north of Edgar. Lat./Long. 40.44405/-97.94042.

Hansen WPA. Area 296 acres of seasonal wetland and 394 upland acres. Located 0.25 mile west and 3.5 miles north of Ong. Lat./Long. 40.449/-97.848.

Harvard WPA. Area 760 acres of seasonal wetland and 724 upland acres. This is a large, permanent marsh that in prime condition is up to about four feet deep. The eastern side has some restored native prairie. Jorgensen (2004) reported that, of all the Rainwater Basin wetlands that he surveyed, Harvard had the largest number of shorebirds during the four springs of his study. Sandhill cranes probably nested here as early as 1996, and certainly nested in 1999. American avocets have also nested here, and Wilson's phalaropes probably have as well. An information kiosk is present at the southwest parking lot. Located two miles west of Harvard. Probably the best road access and overlook location is from the south side, accessed by driving one mile south of Harvard, 2.5 miles west and one mile north to a parking area beyond the railroad crossing. There are also entrances along the north and west sides. Lat./Long. 40.614/-98.181.

Hultine WPA. Area 583 acres of seasonal wetland and 417 upland acres. A prairie dog town is present. Located six miles east of

Harvard, or five miles west of Sutton. Lat./Long. 40.628/-97.973.

Kissinger Basin WMA. 490 acres, mostly of seasonal wetland. Sandhill cranes nested here in 1999. In recent years this wetland has been very attractive to spring waterfowl. Located 0.5 mile north of Fairfield. Lat./Long. 40.44492/-98.09886.

Lange WPA. Area 56 acres of seasonal wetland and 104 upland acres. Located 0.25 mile east and two miles south of Sutton. Lat./Long. 40.563/-97.846.

Massie WPA. Area 494 acres of seasonal wetland and 359 upland acres. This important wetland is sometimes pumped to maintain spring water levels. The wetlands are heavily overgrown by summer, and the site's breeding birds are still largely undocumented. Jorgensen (2004) reported that, of all the Rainwater Basin wetlands that he surveyed, Massie had the third-largest number of shorebirds during the four springs of his study. Its southeastern portion has been reseeded to native prairie. An elevated viewing tower is accessible from the south entrance, and an information kiosk is present. From Clay Center, drive three miles south on Nebraska Highway 14, then east 0.5 mile. Lat./Long. 40.479/-98.083.

Meadowlark WPA. 80 acres, including some seasonal wetland. Located three miles east and three miles south of Clay Center. Lat./Long. 40.4736/-99.995.

Moger WPA. Area 72 acres of seasonal wetland and 125 upland acres. Some prairie grasses and a prairie dog town is present. Located three miles east and two miles south of Clay Center. Lat./Long. 40.483/-978/992.

North Hultine W. P. A (previously known as Sandpiper, a name already chosen for a WMA. site in Fillmore County). Area 226 acres of seasonal wetland and 214 upland acres. Located six miles east and one mile north of Harvard, or two miles west and 1.5 mile north of Saronville. Lat./Long. 40.499/-97.714.

Shuck WPA. Area 89 acres, including some seasonal wetland. Located one mile west and 5.5 miles south of Geneva. Lat./Long. 40.458/-99.997.

Smith WPA. Area 226 acres of seasonal wetland and 254 upland acres, with some native prairie. Located six miles south and 3.5 miles east of Clay Center, or four miles north of Edgar. Lat./Long. 40.439/-97.974.

Theesen WPA. Area 46 acres of seasonal wetland and 34 upland acres. Located 1.5 mile northwest of Glenville. Lat./Long. 40.512/-98.273.

Verona WPA. Area 160 acres, with a small wetland and some virgin native prairie. Located 4.5 miles east and 1.5 miles north of Clay Center. Ownership: Ducks Unlimited. Lat./Long. 40.512/-98.273. The adjacent Ducks Unlimited's Verona Complex is located immediately to the south and west. It has an observation blind and is public-access.

White Front WMA. Area 280 acres of mixed seasonal wetland and upland. Located two miles west and 1.5 mile north of Clay Center. Lat./Long. 40.55009/-98.08216.

FILLMORE COUNTY

Fillmore County is an eastern Rainwater Basin and loess plains county, with 1,600 acres of surface water. The county's area is 577 square miles (averaging 5.7 people per square mile). It contains ten waterfowl production areas, and four wildlife management areas. Most of the following sites are seasonal playas at the eastern end of the Rainwater Basin.

Bluebill WMA. Area 60 acres, including two small marshes. Located 0.5 mile north and 0.25 mile east of Grafton. Lat./Long. 40.636/-97.703.

Brauning WPA. Area 165 acres of seasonal wetland and 75 upland acres. Located 0.5 mile west and 1.75 miles south of Grafton. Lat./Long. 40.6/-97.724.

County Line WPA. Area 224 acres of seasonal wetland and 182 upland acres. Located three miles south and three miles east of McCool Junction. Lat./Long. 40.7027/-97.5419.

Greiss WPA. Area 40 acres, including some seasonal wetland. Located 3.5 miles east, 1.5 mile south of Sutton. Lat./Long. 40.584/-97.776.

Krause WPA. Area 303 acres of seasonal wet-

land and 224 upland acres. Sandhill cranes reportedly nested here in 1996. Located four miles west and 3.5 miles north of Shickley, or two miles east and five miles north of Ong. Lat./Long. 40.472/-997.797.

Mallard Haven WPA. Area 633 acres of seasonal wetland (pumped seasonally) and 454 upland acres. An information kiosk is present. One of the largest and best waterfowl marshes during spring, attracting many grassland and wetland birds. Jorgensen (2004) reported that, of all the Rainwater Basin wetlands that he surveyed, Mallard Haven had the second-largest number of shorebirds during the four springs of his study. Located 0.5 mile west and 1.5 mile north of Shickley. Lat./Long. 40.448/-97.744.

Marsh Hawk WMA. Area 173 acres mostly seasonal wetland. Located 0.5 mile north of Grafton. Lat./Long. 40.63677/-97.72174.

Millers Pond WPA. Area 131 acres. Mixed seasonal wetland and upland. Located two miles south of Shickley. Lat./Long. 40.387/-97.731.

Morphy WPA. Area 76 acres of seasonal wetland and 12 upland acres. Located one mile west and one mile south of Grafton. Lat./Long. 40.611/-97.732.

Rauscher WPA. Area 140 acres seasonal wetland and 111 upland acres. Located 2.5 miles west and three miles south of Grafton. Lat./Long. 40.585/-97.764.

Redhead WMA. Area 160 acres. Located five miles west and 0.5 mile north of Shickley. Lat./Long. 40.43393/-97.81916.

Real WPA. Area 121 acres of seasonal wetland and 39 upland acres. Located 2.25 miles north of Fairmont. Lat./Long. 40.672/-97.575.

Rolland WPA. Area 53 acres of seasonal wetland and 76 upland acres. Located two miles north of Shickley, or 1.5 mile east and 0.5 mile south of Sutton. Lat./Long. 40.59/-97.821.

Sandpiper WMA. Area 160 acres, including ca. 50 aces of seasonal wetland. Located five miles west and one mile south of Geneva. Lat./Long. 40.49906/-97.71439.

Weiss WPA. Area 120 acres of seasonal wetland and 40 upland acres, Located two miles north of Shickley. Lat./Long. 40.455/-97.732.

Wilkins WPA. Area 320 acres of seasonal wetland and 208 upland acres. Located one mile east and one mile south of Grafton. Lat./Long. 40.609/-97.675.

HAMILTON COUNTY

Hamilton County is a Platte River valley and eastern Rainwater Basin county, with less than 1,000 acres of permanent surface water plus many seasonal wetlands. The county's area is 544 square miles (averaging 17.5 people per square mile). It contains three waterfowl production areas and three wildlife management areas. Its entire northern boundary is formed by the Platte River.

Deep Well WMA. Area 240 acres, including a 70-acre marsh. Located 3.5 miles south of Phillips. Lat./Long. 40.845/-98.22075.

Gadwall WMA. Area 90 acres Includes two borrow-pit wetlands and a narrow slough. Located one mile west and 4.5 miles north of Aurora. Lat./Long. 40.94006/-98.03742.

Nelson WPA. Area 143 acres of seasonal wetland and 17 upland acres. Located three miles north of Stockham. Lat./Long. 40.759/-97.937.

Pintail WMA. Area 268 acres of seasonal wetland, 185 acres of cropland and 25 acres of pasture. Located 2.5 miles south and two miles east of the Aurora I-80 exit 332, or 0.5 mile west and five miles north of Stockham. Lat./Long. 40.78544/-97.95429.

Springer WPA. Area 397 acres of seasonal wetland acres and 243 upland acres. Contains some native prairie in the southwestern corner. Located six miles west and one mile south of Aurora, or one mile east and 4.5 miles north of Giltner. Lat./Long. 40.849/-98.128.

Troester Basin WPA. Area 123 acres of seasonal wetland and 37 upland acres. Located 4.5 miles north and 0.5 mile east of Stockham. Lat./Long. 40.797/-97.924.

NUCKOLLS COUNTY

Nuckolls County is an eastern Rainwater Basin and loess plains county, with 1,200 acres of per-

manent surface water. The county's area is 575 square miles (averaging 8.2 people per square mile). It contains two wildlife management areas, and is crossed diagonally by the Little Blue River.

Smartweed Marsh WMA. Area 74 acres of wetland, seven acres of grassland. Located two miles west and 1.5 mile south of Edgar. Lat./Long. 40.33286/-98.01271.

Smartweed Marsh West WMA. Area 50 acres. WMA. Located 3.5 miles west and 1.5 mile south of Edgar. Lat./Long. 40.34193/-98.0375. Lat./Long. 40.342/-98.036.

SALINE COUNTY

Saline County is an eastern Rainwater Basin and loess plains county, with 1,900 acres of permanent surface water. The county's area is 575 square miles (averaging 24.9 people per square mile). It contains one waterfowl production area, one wildlife management area, and is crossed diagonally by the Big Blue River.

Schwisow WPA. Area 61 acres, including a one-acre permanent wetland, the southeasternmost of the Rainwater Basin wetlands. Located 1.5 mile east of Western, Lat./Long. 40.391/-97.166.

Swan Creek WMA. Area 160 acres. A 27-acre reservoir on Swan Creek, plus marshland, native prairie and woods. Located nine miles south and one mile east of Friend. Lat./Long. 42.16534/-99.03836.

SEWARD COUNTY

Seward County is an eastern Rainwater Basin and loess plains county, with 1,500 acres of surface water. The county's area is 575 square miles (averaging 29.4 people per square mile). It contains one state recreation area, two waterfowl production areas, four wildlife management areas, and is crossed diagonally by the Big Blue River.

Branched Oak S. R. A. See Lancaster County (in Saline Wetlands Region).

Freeman Lakes WPA. Area 188 acres, including 146 wetland acres. Jorgensen (2004) reported that, of all the Rainwater Basin wetlands that he surveyed, Freeman Lakes had the fifth-largest total number of spring shorebirds seen during the four years of his study. Located one mile west and 15 miles north of Utica. Lat./Long. 40.931/-97.364.

North Lake Basin WMA. Area 364 acres. Marshy wetland and adjoining upland. Located one mile north of Utica. Lat./Long. 40.91502/-97.34216.

Straight Water WMA. Area 240 acres. Located 2.5 miles north and one mile west of Goehner. Lat./Long. 40.86913/-97.2326.

Tamora WPA. Area 228 acres of seasonal wetlands and 52 upland acres. One of the easternmost of the Rainwater Basin wetlands. Located six miles west and two miles south of Seward, or 0.5 mile south of Tamora. Lat./Long. 40.886/-97.9722.

Twin Lakes WMA. Area ca. 1,300 acres. Includes 255- and 50-acre reservoirs, marshes, wooded bottomlands, upland prairie and ponds. Located one mile north and one mile west of I-80 exit 388. Lat./Long. 40.83408/-96.9534.

THAYER COUNTY

Thayer County is an eastern Rainwater Basin and loess plains county, with nearly 2,000 acres of permanent surface water. The county's area is 575 square miles (averaging 9.2 people per square mile). It contains one waterfowl production area, two wildlife management areas, and its entire east-west width is crossed by the Big Blue River.

Father Hupp WMA. Area 160 acres, including 135 acres of wetland. Located 2.5 miles west of Bruning. Lat./Long. 40.34011/-97.61765.

Prairie Marsh. WMA. Area 73 acres, including a one-acre wetland. Located 4.5 miles west and 0.5 mile north of Bruning. Lat./Long. 40.34539/-97.64625.

YORK COUNTY

York County is an eastern Rainwater Basin and loess plains county, with nearly 3,000 acres of permanent surface water. The county's area is 576 square miles (averaging 24.5 people per square mile). It contains four waterfowl production areas, five wildlife management areas, and nearly its entire its width is crossed by the West Fork of the Big Blue River.

County Line WPA. See Fillmore County.

Heron WPA. Area 350 acres, including 215 acres of wetland. Located 0.25 mile west and six miles north of Bradshaw. Lat./Long. 40.924/-97.373.

Hidden Marsh WMA. Area 120 acres. A playa wetland. Located two miles west and two miles north of Edgar. Lat./Long. 40.70951/-97.48761,

Kirkpatrick Basin North WMA. Area 70 acres of semi-permanent wetlands, l75 acres of seasonal wetlands, and about 100 acres of upland. Located 3.5 miles west and two miles south of York. From I-80, take Exit 348, go north 0.5 mile, and then east one mile. Lat./Long. 40.82708/-97.6669.

Kirkpatrick Basin South WMA. Area 305 acres. A large playa wetland. Located four miles east and 1.25 mile north of Henderson, or seven miles west and five miles south of York. Lat./Long. 40.80464/-97.72488.

Krause WPA. Area 303 acres of seasonal wetland and 224 upland acres, with a large area of native grasses. Located 4.5 miles north of Shickley, or two miles east and five miles north of Ong. Lat./Long. 40.472/-97.797.

Sinninger WPA. Area 42 acres of seasonal wetland and 118 ac upland. Located 2.5 miles east and two miles south of McCool Junction in York County, or 2.5 miles east and two miles south of McCool Junction. Lat./Long. 40.716/-97.536.

Spikerush WMA. Area 194 acres. Mixed seasonal marsh and upland habitats. Located 0.75 mile north and one mile west of Waco. Lat./Long. 40.91052/-97.48675.

Straight Water WMA. Area ca. 150 acres. Mixed seasonal marsh, wet meadow and upland habitats. Located 0.5 mile west and two miles north of Goehner. Lat./Long. 40.86913/-97.2326.

Waco WPA. Area 113 acres of seasonal marsh and 46 upland acres. Located one mile west and 0.5 mile north of Waco. Lat./Long. 40.911/-97.479.

THE WESTERN RAINWATER BASIN

FRANKLIN COUNTY

Franklin County is a Republican River valley and western Rainwater Basin county, with about 1,500 acres of surface water, plus many seasonal wetlands. The county's area is 576 square miles (averaging 5.7 people per square mile). It contains three waterfowl production areas, two wildlife management areas, and its entire east-west width is bounded by the Republican River.

Quadhammer WPA. Area 584 acres, including 308 acres of seasonal wetland and 286 upland acres. Located three miles west and one mile south of Hildreth. Lat./Long. 40.3/-99.1.

Ritterbush WPA. Area 81 acres, including 49 acres of seasonal wetland and 32 upland acres. Located five miles south of Hildreth. Lat./Long. 40.26/-99.043.

GOSPER COUNTY

Gosper County is a mostly high plains and loess canyon county, with less than 4,000 acres of surface water, consisting mostly of reservoirs. The county's area is 458 square miles (averaging 4.4 people per square mile). It contains three waterfowl production areas and two wildlife management areas. Its entire east-west width is crossed by Plum Creek.

Elley Lagoon WPA. Area 62 acres, including 33 acres of seasonal wetland and 29 upland acres. Located three miles south and two miles west of Bertrand. Lat./Long. 40.486/-99.684

Elwood Reservoir WMA. Area ca. 2,200 acres, including a l,330-acre reservoir and 900 upland acres. Located two miles north of Elwood. Lat./Long. 40.62673/-99.85837.

Peterson WPA. Area 1,154 acres, including 527 acres seasonal wetland and 627 upland acres. Located one mile west and two miles south of Bertrand. Lat./Long. 40.489/-99.658.

Victor Lake WPA. Area 238 acres, including 174 acres seasonal wetland, and 64 upland

acres. From Bertrand drive four miles north, three miles east, and one more mile north. Lat./Long. 40.594/-99.654.

KEARNEY COUNTY

Kearney County is a Platte River valley county in the western Rainwater Basin, with about 200 acres of permanent surface water, plus many seasonal wetlands, including all those listed below. The county's area is 516 square miles (averaging 13.1 people per square mile). It contains nine waterfowl production areas, one wildlife management area, and its entire northern border is bounded by the Platte River.

Bluestem WPA. Area 44 acres of seasonal wetland and 32 upland acres. Located three miles south and five miles east of Axtell. Lat./Long. 40.441/-99.058.

Clark WPA. Area 227 acres of seasonal wetland and 222 upland acres. Located three miles north of Hildreth. Lat./Long. 40.378/-99.053.

Fort Kearney S. R. A. 163 acres. Includes about one mile of Platte River frontage, riparian woods, six gravel-pit lakes (totaling 23 acres), and access to a hike-bike bridge across the Platte. Sandhill crane roosting flights may be seen from this bridge, and American woodcocks often display near its north end. Fort Kearny State Historic Park is one mile north and offers crane-related information. From Kearney, drive two miles south on State Highway 44, then four miles east on county road L50A and north on access road. State park permit required (Ph. 308/865-5305). Lat./Long. 40.65493/-98.99636.

Frerichs WPA. Area 33 acres of seasonal wetland and 10 upland acres. Located two miles east and 0.5 mile north of Wilcox. Lat./Long. 40.372/-99.125.

Gleason WPA. Area 197 acres of seasonal wetland and 372 upland acres. Located four miles south and four miles west of Minden. Lat./Long. 40.435/-99.025.

Jensen WPA. Area 187 acres of seasonal wetland and 278 upland acres. Located six miles north of Campbell. Lat./Long. 40.4/-97.744.

Killdeer Basin WPA. Area 36 acres, mostly seasonal wetland. Located thee miles west and 3.6 miles north of Hildreth. Lat./Long. 40.389/-99.104.

Lindau WPA. Area 105 acres of seasonal wetland and 47 upland acres. Located five miles north and 0.5 mile east of Hildreth. Lat./Long. 40.402/-99.036.

Prairie Dog WPA. Area 471 acres of seasonal wetland and upland. A prairie dog town is located here, and burrowing owls often are present from late April through mid-September. Located 5.5 miles south of Axtel, or two miles east and two miles north of Wilcox. Lat./Long. 40.402/-99.13.

Youngson WPA. Area 113 acres of seasonal wetland and 70 upland acres. Located six miles south and five miles east of Norman. Lat./Long. 40.396/-98.785.

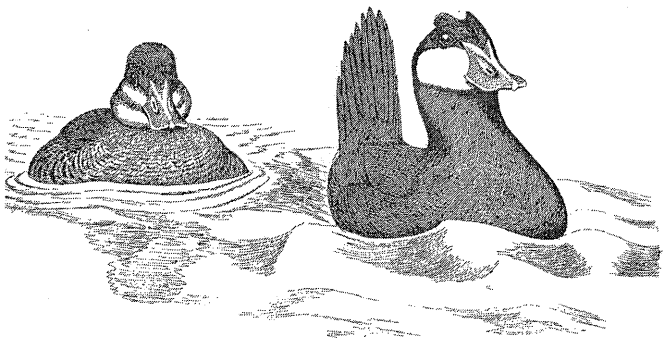
PHELPS COUNTY

Phelps County is a Platte River valley county in the western Rainwater Basin, with less than 200 acres of permanent surface water, plus many seasonal wetlands. The county's area is 540 square miles (averaging 13.9 people per square mile). It contains six waterfowl production areas, three wildlife management areas, and its entire east-west width is crossed by the Platte River.

Atlanta WPA. Area 453 acres of seasonal wetland and 659 upland acres. A large wetland basin with a prairie dog town. The north-central part of the site includes some restored prairie. Located 0.5 mile north of Atlanta, or six miles west and three miles south of Holdrege. Lat./Long. 40.382/-99.478.

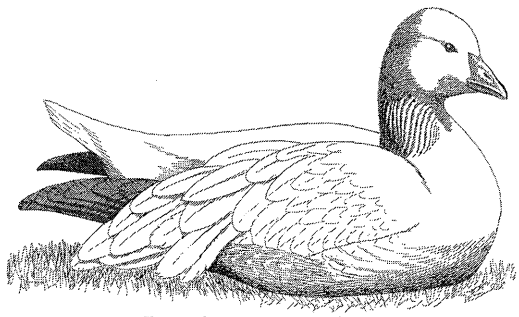
Cottonwood WPA. Area 550 acres, including 79 acres of seasonal wetland and 471 upland acres. This playa wetland is sometimes used by whooping cranes. Located one mile north and 1.5 mile east of Bertrand. Lat./Long. 40.547/-99.584.

Fig. 26



Ruddy duck, male displaying to female

Fig. 28



Ross's goose, adult

Funk Lagoon WPA. Area 1,989 acres, including 1,163 acres of seasonal wetland and 826 upland acres. The largest protected Rainwater Basin wetland, and one with some of the best shallow marsh habitat in favorable years. Up to a million or more waterfowl and occasional whooping cranes use the area in spring during wet years, but in have been reported here (one of the largest local species lists in the state), including about 20 species of ducks. Reported breeders include the least bittern, black-necked stilt, Virginia rail, swamp sparrow, great-tailed grackle, and many other common wetland species. There is a viewing blind on the north-south road, an information kiosk and several miles of mowed paths. A Rainwater Basin office is also located at the north end of the site. Located one mile east and three miles north of Funk. Lat./Long. 40.498/-99.227.

High Basin WMA. Area 44 acres of seasonal wetland and 74 upland acres. A playa wetland located two miles north of Bertrand. Lat./Long. 40.56492/-99.63964.

Johnson Lagoon WPA. Area 252 acres of seasonal wetland and 326 upland acres. A shallow playa sometimes used by migrant whooping cranes. Located seven miles north and 2.5 miles east of Holdrege. Lat./Long. 40.556/-99.326.

Jones Marsh WPA. Area 90 acres of sea-

sonal wetland and 76 upland acres. A playa wetland located three miles west and three miles south of Holdrege. Lat./Long. 40.39/-99.432.

Linder WPA. Area 160 acres. Located one mile north and five miles east of Bertrand. Lat./Long. 40.541/-99.534.

Sacramento-Wilcox WMA. Total area (including West Sacramento, South Sacramento and Southeast Sacramento units) 3,023 acres, with 1,050 acres of seasonal and permanent wetlands, with diked areas and pumping facilities. Located about 2.5 miles west of Wilcox. Lat./Long. 40.37246/-99.24107.

West Sacramento WMA. Area 200 acres of seasonal wetland and 188 upland acres. A playa wetland located four miles south and four miles west of Holdrege. Lat./Long. 40.36439/-99.31268.

THE TODD VALLEY PLAYA REGION

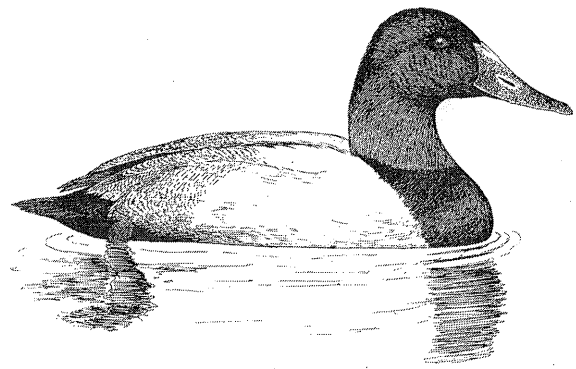
This relatively small region includes paleovalleys that are the remnants of ancient Platte River channels formed in Pleistocene times. One extends east between the Platte and Shell Creek, and along Logan Creek. Todd Valley begins a few miles west of Fremont and extends southeasterly to southern Saunders County. This valley marks a region where the Platte had once cut down into Mesozoic and Paleozoic bedrock, with outcrops of Cretaceous-era Dakota sandstone visible along the valley edges. Todd Valley merges with the present-day Platte–Elkhorn floodplain southeast of Mead (Wayne, 1987; Maher, Engelmann and Shuster, 2003).

PLATTE COUNTY *(see also Loup River Valley Wetlands, Chapter 5)*

Platte County is a Loup River–Platte River county, with almost 3,000 acres of surface water). The county's area is 675 square miles (averaging 46.1 people per square mile. It contains two wildlife management areas. Its southern border is bounded by the Platte River, and the Loup River also extends over most of its southern portion before merging with the Platte.

Wilkinson WMA. Area 957 acres. Upland grassland and managed wetlands located between the Loup River and Shell Creek, including nine independently controlled wetlands within a depression that was once a large playa wetland. Probable nesting wetland birds include the great blue heron, pied-billed grebe, American bittern, Virginia and sora rails, Bell's vireo, marsh and sedge wrens, common yellowthroat, swamp sparrow, red-winged and yellow-headed blackbirds, bobolink and great-tailed grackle. Jon Farrar (2004) listed 33 birds as a "sampler" of the area's bird life, of which 22 are typical wetland species such as those mentioned above, and several migrant shorebirds and waterfowl. Located five miles west and one mile north of Columbus, off U.S. Highway 81. Lat./Long. 41.50423/-97.49384.

Fig. 29



Canvasback adult male

Table 13

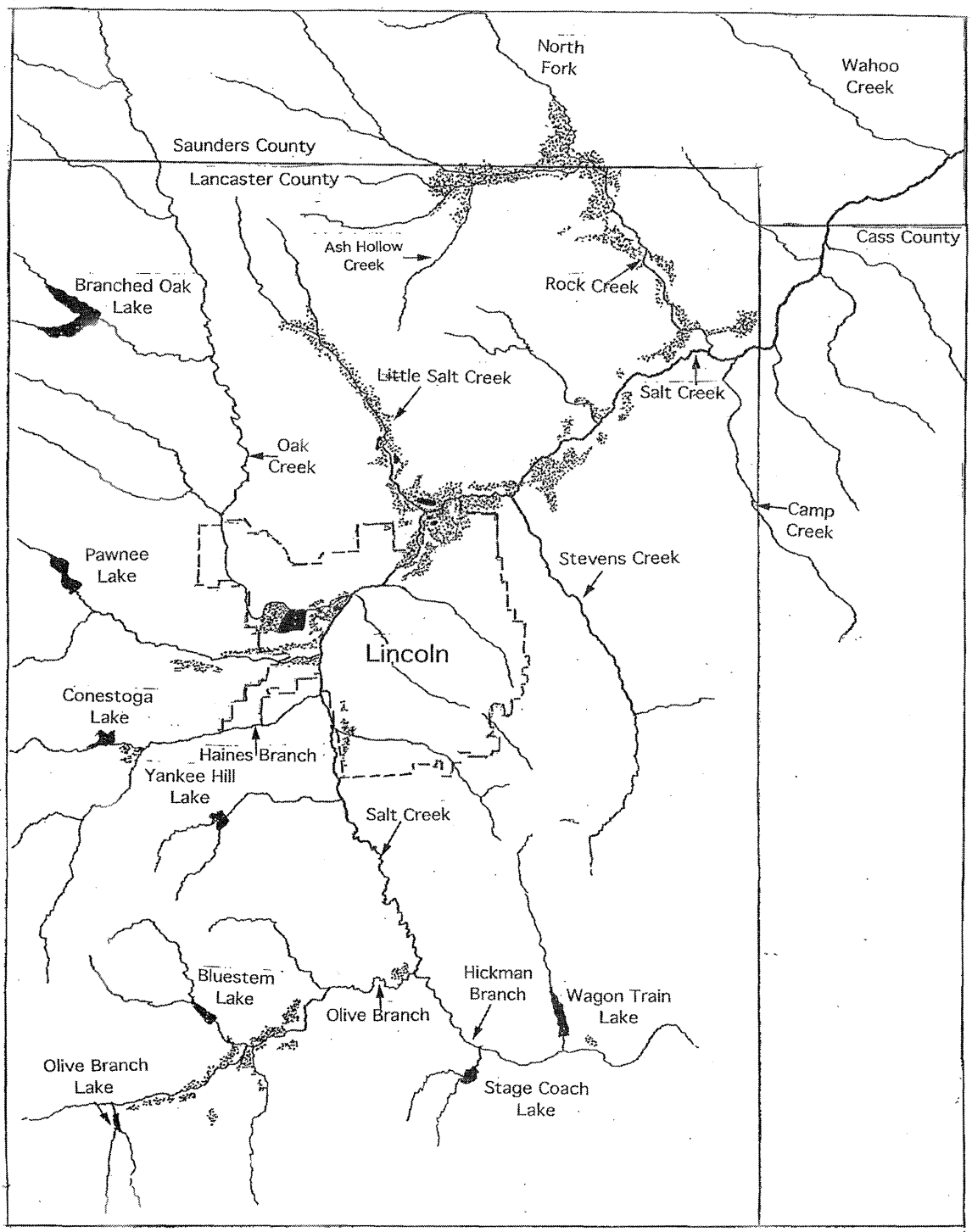
Aquatic Invertebrates of Nebraska's Rainwater Basin*

	Water Column	Benthic Core	Activity Trap
MICROINVERTEBRATES			
Phylum Arthropoda (arthropods)			
Class Crustacea (crustaceans)			
Order Cladocera (water fleas)			
Family Bosminidae	XXX		
Family Daphnidae	XXX		
Order Copepoda (copepods)	XXX		
Order Ostracoda (seed shrimp)			X
Phylum Nematoda (roundworms)	XX	X	
Phylum Rotatoria (rotifers)	XXX		
Phylum Tardigrada (water bears)	X		
MACROINVERTEBRATES			
Phylum Mollusca (mollusks)			
Class Gastropoda (univalve mollusks)			
Family Lymnaeidae (pond snails)	p		
Family Physidae (pouched snails)	X	X	X
Family Planorbidae (ram's horn snails)	X	X	
Phylum Annelida (segmented worms)			
Class Hirudinea (leeches)	X	X	X
Class Oligochaeta (earthworms)	X	X	X
Phylum Arthropoda (arthropods)			
Class Arachnoidea (mites, ticks, spiders)			
Order Acari (mites, ticks)	X		X
Class Crustacea (crustaceans)			
Order Amphipoda (scuds)	X		X
Order Anostraca (fairy shrimps)	p		
Order Conchostraca (clam shrimps)	X	X	
Class Insecta (insects)			
Order Coleoptera (beetles)			
Carabidae (predaceous ground beetles)		X	
Chrysomelidae (leaf beetles)		X	
Dytiscidae (predaceous diving beetles)	p		X
Gyrinidae (whirligig beetles)			X
Hydrophilidae (water scavenger beetles)	p		
Order Collembola (springtails)	p		X
Order Diptera (two-winged flies)			
Ceratopogonidae (biting midges)	X	X	X

	Water Column	Benthic Core	Activity Trap
Chaoboridae (phantom midges)	X	X	X
Chironomidae (midges)	X	X	X
Culicidae (mosquitoes)	p	X	X
Muscidae (house flies. stable flies)		X	
Stratiomyidae (soldier flies)	p	X	
Order Ephemeroptera (mayflies)			
Beatidae (small minnow mayflies)	X		X
Caenidae (small square-gill mayflies)		p	X
Order Hemiptera (true bugs)			
Corixidae (water boatmen)		X	X
Notonectidae (backswimmers)		X	X
Order Odonata (dragonflies and damselflies)			
Suborder Anisoptera (dragonflies)	X		X
Suborder Zygoptera (damselflies)	X	X	X
Order Thysanoptera (thrips)	p		

* "* "XXX" = >500 individuals per unit measurement; "XX" = 100-500 per unit measurement; "X" indicates presence in measurable numbers; "p" indicates presence in minute amounts. Taxa are arranged alphabetically. Based on May to July collections in eight wetland sites, Phelps, Clay, Fillmore and York counties (Gordon, Flake and Higgins, 1990).

Map 7



The eastern saline wetland region, showing Salt Creek drainage, with saline soil areas indicated by stippling. The locations of Lincoln (dashed line) and larger reservoirs within the Salt Creek basin are also shown. Stippled areas indicate saline soils. Adapted from Farrar & Gersib (1991) *(Eastern Saline Wetlands, Chapt. 8)*

Chapter 8

The Eastern Saline Wetlands Region

Lancaster County in southeastern Nebraska is the center of the Salt Creek drainage basin, which supports nearly 300 small saline wetlands now having a collective size of less than two square miles. The salinity is produced by groundwater passing though the underlying Dakota sandstone, a Cretaceous-era sedimentary deposit dating back to about 100 million years, when what is now present-day Nebraska and the rest of the Great Plains were covered by a vast inland sea (Maher, Engelmann and Shuster, 2003). The salinity associated with these seawater deposits has been enhanced by surface evaporation, producing such surface phenomena as the historic "Great Basin" or "Salt Lake" (now known as Capitol Beach Lake), around which the settlement of Lancaster (now Lincoln) developed, beginning in the mid-1800s.

In 1867 F. V. Hayden of the U. S. Geological Survey, reported that the Great Basin covered an area of about 400 acres, and the brine in it came to the surface from many places, at the rate of 6–8 gallons per minute. A second basin of about 200 acres was present between Oak Creek and Salt Creek, and a third one of the same size was on lower Little Salt Creek. Several other small basins were present in the same general area.

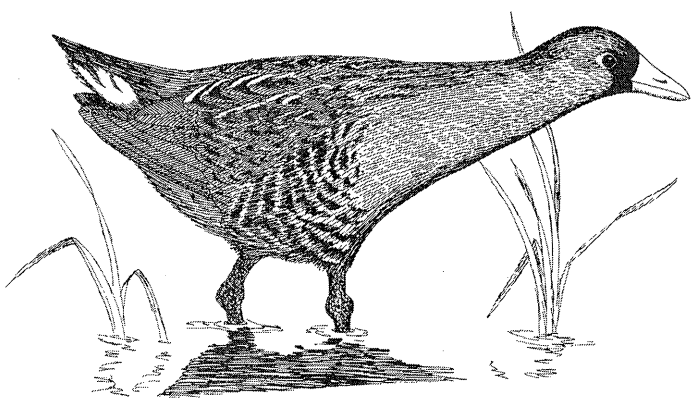
Unlike nearly all other Nebraska streams, Salt Creek flows in a general north to northeasterly direction. It originates about 20 miles southwest of Lincoln, from two headwater tributaries (Olive Branch and Hickman Branch creeks) (**Map 7**). In the vicinity of Lincoln other tributaries arriving from the west and north bring in distinctly saline waters and, northeast of Lincoln, Rock Creek adds additional salinity. Salt Creek merges with the Platte River east of Ashland, after flowing some 52 miles and draining 1,627 square miles (Farrar and Gersib, 1991).

In part because of their proximity to Lincoln and the University of Nebraska, the historic salt lake basins received a great deal of attention form biologists. Over 230 bird species had reported from Lancaster County's salt basins by 1900 (**Table 14**), and the wetlands were an important migratory stopping place for shorebirds, waterfowl, herons, and other wading birds. Piping plovers once nested around Salt Lake, and more recently several relatively rare species such as common moorhen, king rail and least bittern have been found breeding in the few remnant marshes.

The plants of the Salt Creek basin are now well studied too, and include several species unique or nearly unique to Nebraska (**Table 15**). Saltwort and sea bite are the most salt-tolerant of these, and these species are able to survive on otherwise barren salt-crusted earth. Other species that comprise the salt flat community include, in approximate sequence of their increasing tolerance to salinity, are salt marsh aster, spearscale, marsh elder and inland saltgrass.

These salt-adapted communities have been greatly reduced in size, as Lincoln has grown to encompass the original Salt Basin (Capitol Beach) and adjacent reaches of Salt Creek, and has expanded north into the lowest reaches of Little Salt Creek. A 1990 Game and Parks Commission survey of Lancaster and Saunders counties produced an estimate of 1,200 acres of saline wetlands in the two counties, including 133 surviving saline wetlands and 99 freshwater wetlands that had once been saline. Most of these wetlands were smaller than 20 acres, and ranged to a maximum of slightly over 200 acres. The largest remaining area of protected saline wetlands is in southern Saunders and adjacent northern Lancaster County near Ceresco. There, the Jack Sinn Memorial Wildlife Management Area covers about 1,500 acres, and has several saline wetlands that are maintained by diking and silt removal (Farrar and Gersib, 1991).

Fig. 31



Sora, adult

Natural History Profiles of Some Saline Wetland Species

King, Sora and Virginia Rails

All the rails are marshland birds, occupying both fresh-water and saline marshes in Nebraska. King rails apparently have the most diverse habitats of Nebraska's rail species, ranging in various parts of their range from salt-water to fresh-water marshes, swampy wetlands, and even upland fields. Although rails can swim, they typically forage from a standing position along the edges of heavy cover, or where floating plants allow for easy walking. Their ability to compress themselves until they are "thin as a rail" allows them to move unseen through heavy emergent vegetation.

Soras eat mainly seeds, while the Virginia rail feeds heavily on insects. The king rail prefers crustaceans and aquatic insects while on the breeding grounds. They are, however, closely associated with muskrats, along whose water pathways they nest, obtain water, and forage for crayfish.

Evidently all three rail species are monogamous, with yearly establishment or reestablishment of pairs in conjunction with territorial defense. Upon returning to the breeding areas, males establish and proclaim their territories, sometimes in the same place as in previous years, by uttering their distinctive mating calls (the king rail's kik-kik-kik, the the Virginia's ticket-ticket, the sora's whee-hee-hee or whinny). In Virginia rails territorial defense is directed primarily against other members of the same species, but in king rails and soras it includes eviction of all other rails. Once mating has occurred, both sexes probably participate in territorial defense.

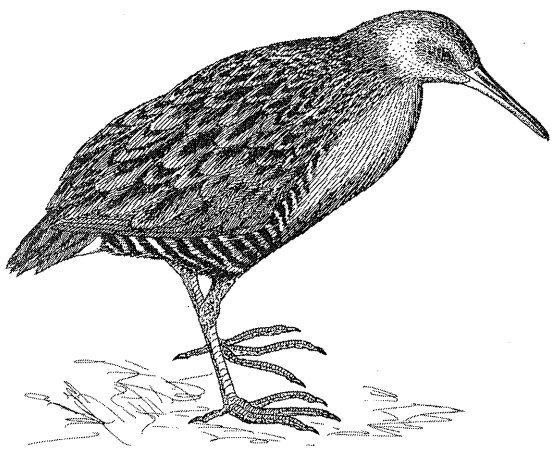
Rails have a variety of additional calls associated with pair-bond maintenance and nesting. Pair-forming displays in the king rail consist largely of the mating call and flashing of the white under tail-coverts, while courtship feeding of the female by the male is evidently an important pair-maintaining display. In the sora and Virginia rails apparently only the latter performs courtship feeding, but pairing and copulatory behavior in both include bouts of preening, standing-lateral displays, precopulatory chases, and postcopulatory movements. Mutual preening and symbolic nest-building by the male have been observed in some rails as well, and may occur in all of these species.

At least in the king rail, the nest site is probably chosen by the male, who may initiate its construction. It is usually provided with both a canopy and a ramp for easy access from water. The male king rail takes the major role in building the nest, which may not be finished before the first egg is laid. All three species also construct several additional brood nests, usually without canopies, near the egg nest. Their nests are usually in fairly uniform stands of vegetation, typically near the edge of heavy cover and close to water.

In all three species the eggs are laid on an approximate daily basis. The sora begins incubation with the first few eggs that are laid, but other species do not initiate it until the clutch is nearly complete.

Clutches usually number from 8–12 eggs. As many as 18 have been seen in a nest, suggesting dump-nesting by more than one female. Thus, hatching may be staggered over as long as 17 days in soras, while in the others it is usually completed in one or two days. Both sexes incubate and defend the nests, feigning injury when threatened and sometimes attacking the intruder. The incubation period is 18—19 days for the sora and Virginia

Fig. 32



Virginia rail, adult

rails, and 21—23 days for the king rail. Both sexes brood the newly hatched young, and in the sora the female sometimes takes the first-hatched birds and leaves the male to attend to the remainder.

The chicks are fed bill-to-bill by the adults for a few days, but as they begin to feed for themselves their begging is increasingly ignored by their parents. They may remain together as a family for a month or more, but the parents may eventually begin pecking them and driving them from their territory. This behavior allows the start of a second brood in areas where the breeding season is long enough. The young of king rails are reportedly able to fly at 63 days, while in sora and Virginia rails flight abilities are reportedly attained after 36 and 25 days respectively. These estimated fledging periods seem to be unusually variable for birds of similar ecologies and foraging behaviors, and may require further study. During their brooding period the adults undergo their postnuptial molt and become flightless for a time, but young birds retain their juvenile flight feathers through their first winter.

Common Gallinule

The common gallinule breeds on or near still waters, from lakes to small ponds, and from small, slowly flowing streams to large rivers. Small water areas with abundant emergent vegetation and peripheral cover are preferred for breeding. This species eats mainly the seeds and fruits of weeds and grasses, although it also occasionally feeds on insects, earthworms, slugs, and snails and, rarely, aquatic vertebrates such as tadpoles and small fish.

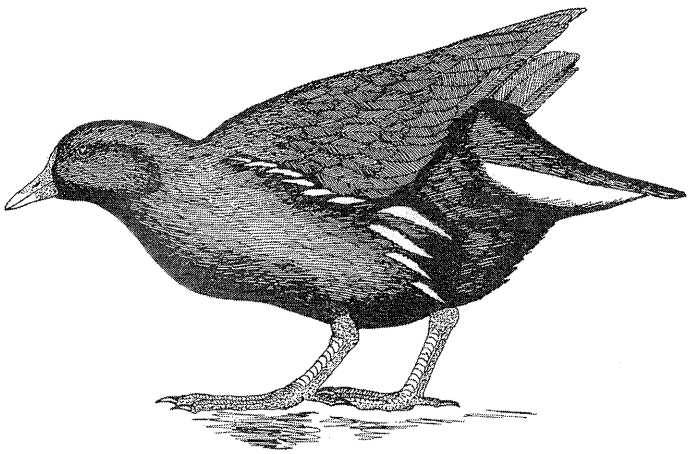
Few detailed observations have been made of the social behavior of wild gallinules, which are both relatively shy and usually found in rather inaccessible habitats. Like other species of gallinules, they are known to be monogamous, highly territorial during the breeding season, and relatively aggressive during nonbreeding periods, when some flocking occurs. Vocalizations are an important part of their social communications, and both sexes have an astonishing variety of notes. Behavior between pairs of common gallinules early in the breeding season centers largely on nest-like display platforms, one of which may later be converted into a nest. Males repel intrusions into their territory by other gallinules of either sex with threats or attack; and after pair bonds are formed, both mates participate in expelling intruders.

At least in common gallinules both sexes take part in nest-building, but it is chiefly done by the male. In the closely related purple gallinule (*Porphyrio martinica*) a well-developed and carefully constructed runway is built from the water to the nest and is invariably used by adults. The common gallinule sometimes makes a less elaborate runway. The clutch size in both species is usually about 6—8 eggs, laid on consecutive days (at least in the common gallinule). Incubation may begin with the first or second egg, or sometimes not until the clutch is complete. Incubation is shared by both sexes, in several-hour shifts, and the changeover may be marked by the presentation of a reed or leaf to the incubating bird, which adds it to the nest before leaving.

Incubation lasts 19—22 days in the common galli-

nule and, depending on when incubation began, the young may hatch all at the same time or at intervals over a period of up to a week. The newly hatched chicks are left in the nest initially, and the parents remove the eggshells and eat the droppings of the chicks. They are fed bill-to-bill by the parents, mainly insects and other small animals. After a few days the chicks leave the nest and closely follow the parents, who continue to feed them for several weeks.

Fig. 33



Common gallinule, adult

One or more brood nests may be built in the brooding area and used by the family. By about five weeks of age the young can largely feed on their own, and they can fly in six to seven weeks. Multiple brooding is the general rule, and three or perhaps more broods may be raised in regions where the breeding season is long enough. The young of previous broods remain in the vicinity of the adults, and have even been reported to help care for later broods.

Salt Creek Tiger Beetle

Tiger beetles are small, very active diurnal and predatory beetles. They occur in many habitats, and many are notable for their colorful dorsal patterning. They can run very rapidly, and can also take flight easily. They hunt in broad daylight, and on dark days or at night they hide effectively in holes or under various types of cover. Among the many habitats occupied in Nebraska are sand dunes, unvegetated or slightly vegetated riverbanks, roadsides, and saline flats. Of the 85 species known of the family's largest and most typical tribe (Cicindelini) from the United States, 30 forms (28 species and two additional subspecies) have been found in Nebraska. Of these, the rarest is the Salt Creek tiger beetle, a highly localized race of a much more widely distributed species. A second race also occurs in the Nebraska Sandhills and High Plains, and occurs widely elsewhere in the American Southwest. The Salt Creek race is dark brown or dark olive green on the thickened coverings (elytra) of the forewings, as well as on the head and thorax, with a slight amount of lighter yellowish to whitish spotting. The underside is shiny and uniformly dark green.

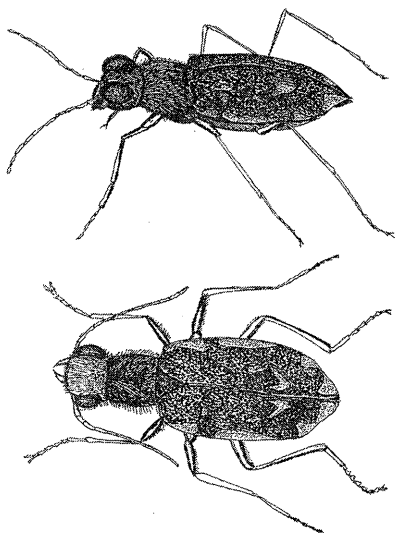
This tiger beetle is active for only a few months in late spring and early summer, from the end of May to mid-July. About 50 eggs are deposited along creek banks. After hatching, the larvae dig into the soil and wait to ambush prey. Larvae go through three developmental stages before becoming adults. There is a two-year life cycle, and a single reproductive cycle per breeding season is typical.

Although once much more common and widespread in Lancaster County, it is now known only from a few wet mud flats that drain these saline flats. These sites include a wetland along I-80 between Capitol Beach and Lincoln's municipal airport, and another near North 27th St., just beyond the city limits and also near I-80. A major part of the species's Lincoln habitat was destroyed by wetland filling during the construction of I—80.

This species has one of the most restricted distributions known for any insect, and its population hovered in the low hundreds during the early 2000's, with 205 in 2010, 310 in 2011, and ranging from a high of 558 in 2004 to a low of 153 in 2005. The beetle has been recognized as nationally endangered, and is thereby also recognized as one of Nebraska's endangered species. In April of 2010 the U.S. Fish & Wildlife Service designated 1,933 acres of wetlands along Salt Creek, Little Salt Creek and Rock Creek as critical habitat. This decision represented a reduction from 14,334 acres in 2005, although academic and agency scientists

had recommended setting aside more than 36,000 acres as critical habitat. A suit filed by The Center for Naïve Ecosystems, the Center for Biological Diversity and the Xerces Society sued the U. S. Fish an Wildlife Service in February of 2001, forcing the agency to re-open the question as to

Fig. 30



Salt Creek tiger beetle

how much land is needed for adequate protection.

Three other tiger beetle species (*C. circumpicta, C. togata, C. fulgida*) also occur in these same areas, but are much more common, and they generally occur on drier substrates. They also remain active much later in the summer.

Saltwort

Like the Salt Creek tiger beetle, this salt-tolerant forb is now largely or entirely limited to a few small saline wetlands in the northern third of Lancaster County, where it is often the only plant growing on the salt-encrusted flats. Chewing one of the succulent and rather scale-like leaves immediately provides for recognition, as these have a distinctly sharp and salty taste. The plant's generic name *Salicornia* refers to salt, and has the same Latin origin as salary (historically, working for one's allotment of salt, thus also the basis for the expression "not worth one's salt"). The plants grow only 3–8 inches tall, and their almost invisible flowers, clustered in groups of threes, are likely to be overlooked. At maturity, the stems turn reddish, the basis for its specific name rubra.

Saltwort is the most salt-tolerant of the Nebraskan alkali flats plants, and often is the only plant growing in highly saline soils. Where soils are less saline, it may be found with sea-bite and saltgrass. Lancaster County almost represents its southernmost range limits, the only more southerly known location being one in central Kansas. It is more common in the Dakotas, especially North Dakota. A member of the goosefoot family Chenopodiaceae (named for the distinctive shape of the leaves in many species), it is an annual herb. Its leaves are scale-like, its tiny flowers are nearly hidden, and its stamens are barely visible. It is most likely to be found in the most alkaline soils, tolerating levels of alkalinity that no other species can attain. In some places the plants grow close together, forming a colony, while in others they are more widely spaced and shrub-like. The species is classified as endangered in Nebraska, but is not listed federally.

The Salt Creek Basin Wetlands

LANCASTER COUNTY

Lancaster County is a Platte River valley county in an area of mixed glacial drift and loess deposits, The county's area is 839 square miles (averaging 321 people per square mile), with nearly 6,000 acres of surface water, nearly all of which consists of reservoirs. Only very little of its surface waters (under 0.01 percent) consist of remnant saline wetlands.

Lancaster County contains seven state recreation areas and eight wildlife management areas. It lies within the Salt Creek drainage, which flows generally northward from its headwaters near the southern end of the county. Most of the county's larger wetlands are impoundments built during the 1960's to control flooding in the Salt Creek Valley. Silting-in has produced marsh-like or swamp-like habitats where feeder creeks empty into the reservoirs.

Arbor Lake WMA. (or Lincoln Saline Wet-

land Nature Center). Area 132 acres. A semi-permanent saline wetland, with water-control structures. Many plants typical of highly saline wetlands occur here. Drive over the intersection of North 27th St. and I-80, then 0.5 mile north of the intersection of N. 27th St. and Arbor Road. The wetland is on the eastern side of N. 27th St., with an off-road parking area and viewing platform. Managed by Nebraska Game & Parks Commission for the City of Lincoln (Ph. 402/476-2729). Lat./Long. 40.90377/-96.67886. URL: http://www.lpsnrd.org.

Bluestem SRA. Area 742 acres, including a 325-acre reservoir The silted-in northern end of this reservoir on Haines Branch Creek is quite marsh-like, with shoreline woods and grassy uplands. Located 2.5 miles west of Sprague. State park entry permit required (Ph. 402/471-5545). Lat./Long. 40.63915/-96.80171.

Branched Oak SRA/WMA. Area 2,980 acres, including a 1,800-acre reservoir. Lancaster County's largest flood-control reservoir, on Middle Oak Creek, with a marsh-like inlet at the north end, shoreline woods, and grassy uplands. The American woodcock is a probable local if rare nester, and riparian lowland forests attract species such as the house wren, eastern towhee, indigo bunting, orchard oriole and Baltimore oriole. Jon Farrar (2004) listed 40 birds as a "sampler" of the Salt Creek Valley reservoir bird life, of which 25 are typical wetland species. Located four miles west of Raymond. State park entry permit required for the SRA.(Ph. 402/783-3400). Lat./Long. 40.97638/-96.84644. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=34

Capitol Beach Saline Wetlands. Area ca. 100 acres. Lowlands along the Capitol Beach's undeveloped eastern side support a remnant free-access saline marsh. King rails, American bitterns black-crowned night-herons and other uncommon marshland birds have been observed here. Location: From Lincoln's Sun Valley Blvd., turn west and then north on Westgate Blvd. Then turn west on Lake Drive and cross railroad tracks to parking area. Owned by the Lower Platte South N. R. D, 3125 Portia, Lincoln, NE 68521. URL: http://www.lpsnrd.org/docs/Recreation/Wetlands.htm#Lincoln

Conastoga Lake SRA. Area 716 acres, including a 230-acre reservoir. A flood-control reservoir surrounded by grasslands and some woods. Located on Holmes Creek (a tributary to Salt Creek), 1.5 mile north and one mile west of Denton. State park entry permit required (Ph. 402/495-2362). Lat./Long. 40.76431/-96.86019.

Frank Shoemaker Marsh. Area 160 acres. A saline marsh in the Little Salt Creek valley, with a trail through wet meadows bordering Little Salt Creek, and two viewing shelters. Includes 50 acres of saline wetlands, providing an important habitat for the nationally endangered Salt Creek tiger beetle. Located on the western side of Lincoln's N. 27th St., across from Arbor Lake WMA. (see above) and 0.5 mile north of intersection of N. 27th St. and Arbor Road (near the intersection of North 27th St. and I-80). Owned by City of Lincoln, 2740 A. St., Lincoln NE. 68502 (Ph. 402/476-2729). Lat./Long. 40.90377/-96.679.

Hedgefield WMA. Area 114 acres. Includes a 44-acre reservoir with some wooded vegetation and grassy uplands. Located three miles west of Panama, on Hickman Branch Creek (a tributary to Salt Creek) (Ph. 402/471-5545), Lat./Long. 40.602/-96.56767.

Jack Sinn Memorial WMA. Area ca. 1,500 acres. The most extensive protected saline wetland in Nebraska, with seasonal to semi-permanent wetlands associated with Rock Creek. Some beaver ponds are present and up to about six feet deep. Nesting wetland species include the Canada goose, mallard, blue-winged teal, American bittern, Wilson's snipe, Wilson's phalarope, sora and Virginia rails, sedge wren, bobolink and great-tailed grackle. Consists of

two separate units, one located about one mile south of Ceresco (Lancaster County), the other about four miles east of Ceresco (Saunders County). Lat./Long. 41.04683/-96.57116.

Killdeer WMA. Area 109 acres. Includes a 20-acre reservoir, with surrounding marsh, wooded ravines, and grassy uplands. Located 2.5 miles north of Martell, on Wittstruck Creek (Ph. 402/471-5545). Lat./Long. 40.67681/-96.76599.

Little Salt Creek WMA. Area 256 acres. A saline wetland along Little Salt Creek, located two miles east of Raymond and 0.25 mile south of Raymond Road and N lst St. Several recently preserved saline wetland areas are nearby. Little Salt Creek West WMA, of 220 acres, is located south of Branched Oak Road between N 1st and NW 12th St. or two miles east and one mile north of Raymond. Little Salt Springs NRD, a Natural Resource District wetland site of 123 acres, is located at the southwestern corner of Branched Oak Road and NW 12th St. Helmuth Marsh, of 119 acres, is owned by Pheasants Forever and is located south of Mill Road and west of NW 14th St. Allen Parcel WMA, of 66 acres, is located between Branched Oak Road and Raymond Road, along the west side of N 1st St.

Little Salt Fork Marsh Preserve. Area 280 acres. A Nature Conservancy saline wetland two miles east of Raymond, north of Raymond Road, on Little Salt Fork Creek. Located north of Little Salt Creek WMA, west of N lth St. Open to limited public use, parking area on Raymond Road(Ph. 402/342-0282).

Olive Creek SRA. Area 572 ac, including a 175-acre reservoir. A flood-control reservoir and grasslands located on Olive Branch Creek (a tributary to Salt Creek) three miles west and three miles north of Hallam. State park entry permit required (Ph. 402/496-2362). Lat./Long. 40.57679/-96.84611. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=131

Pawnee Lake SRA. Area 2,544 acres, including a 740-acre reservoir. Located two miles north of Emerald, 3900 NW. 105th. St. State park entry permit required (Ph. 402/796-262). Lat./Long. 40.84961/-96.88159. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=135

Pfizer Saline Wetlands. A free-access walking trail though saline wet meadows in northwest Lincoln. Located south of intersection of NW. 1st St. and Cornhusker Highway. Owned by the Pfizer Co., 601 W. Cornhusker, Lincoln, NE 68528 (Ph. 402/475-475-4541).

Pioneer's Park. Area ca. 1,100 acres. Largely wooded (mixed deciduous and planted conifers), with some wet meadow and ponds. A nature trail extends from the Chet Ager Nature Center into several hundred acres of restored and native prairie, wet meadows and a seasonal wetland. The nearby Prairie Center has a large area of restored prairie and a dugout wetland. There is a bird list of 246 species, including at least 85 water-dependent species, in addition to many floodplain forest species. Notable floodplain forest breeders include tufted titmouse, Carolina wren, eastern bluebird, rose-breasted grosbeak, indigo bunting, and orchard and Baltimore orioles. Located along Haines Branch Creek (a tributary to Salt Creek), southwest of West Van Dorn and Coddington Ave. A Lincoln municipal park, managed by Lincoln Parks and Recreation Dept., 2740 A. St., Lincoln NE. 68502 (Ph. 402/441-7895).

Roper's Lake. Area ca. 200 acres. An undeveloped city park (Lagoon Park) around an historic salt marsh (Ropers Lake) at the north end of 48th St., just south of the Salt Creek and Little Salt Creek confluence. This is an important saline wetland site for the nationally endangered Salt Creek tiger beetle, whose habitat has been mostly destroyed by the city's still-active landfill. Access permission at the landfill gate is needed (Ph. 402/441-8102 or 441-8104).

Schell Wetlands. Area 123 acres. A half-mile

stretch of Little Salt Creek, located southwest of Northwest 12th St. and Branched Oak Road, at the northernmost extent of saline wetlands along this drainage. Owned by the Lower Platte South N. R. D., 3125 Portia, Lincoln, NE 68521, with free public access. (Ph. 402/476-2729). URL: http://www.lpsnrd.org.

Spring Creek Prairie Audubon Center. Area ca. 800 acres. Tallgrass prairie and wetlands that include a spring-fed creek (Spring Creek), two dammed freshwater ponds, a small fen, and a stand of mature floodplain hardwoods. The bird list exceeds 215 species, including at least 74 wetland birds. The plant list exceeds 350 species. Located three miles south of the west edge of Denton along the eastern side of 98th St. Open weekdays (9 a.m.–5 p.m.) and weekend afternoons. Admission donation suggested. Owned by National Audubon Society (Ph. 402/797-2301). URL: http://www.springcreekprairie.org

Stagecoach Lake SRA. Area 607 acres, including a 120-acre reservoir. A flood-control reservoir and grasslands on Hickman Branch Creek, 1.5 mile south and 0.5 mile west of Hickman. State park entry permit required (Ph. 402/496-2362). Lat./Long. 40.59685/-96.64191. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=170

Teal WMA. Area 94 acres, including a 27-acre reservoir, with surrounding wooded bottomland and grassy uplands. Located 2.5 miles south of Kramer on the Olive Branch Creek (a tributary of Salt Creek). Lat./Long. 40.55646/-96.8775.

Wagon Train Lake SRA. Area 1,062 acres, including a 315-acre reservoir. A flood-control reservoir with flooded tree snags at its upper (western) end, and adjoining grasslands. Located on Hickman Branch Creek (a tributary of Salt Creek), two miles east of Hickman. State park entry permit required (Ph. 402/496-2362). Lat./Long. 40.63625/-96.58482. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=180

Warner Wetlands. Area 140 acres. Saline meadows in the 100-year floodplain of the Stevens Creek–Salt Creek confluence. Located near N. 98th St. and U.S. Highway 6, northeastern Lincoln. Free public access. Owned by the Lower Platte South N. R. D., 3125 Portia, Lincoln, NE 68521, (Ph. 402/476-2729). URL: http://www.lpsnard.org.

Whitehead Saline Wetland. Area ca. 100 acres. A small saline wetland within the north city limits of Lincoln. Located near the intersection of N 27th St. and I-80, on eastern side of N. 27th St. (best observed from the parking lot of the Cracker Barrel Old Country Store). Owned by the Lower Platte South N. R. D., 3125 Portia, Lincoln, NE 68521 with free public access (Ph. 402/476-2729). URL: http://www.lpsnrd.org.

Wilderness Park. Area 1,475 acres. This long and narrow park at the south edge of Lincoln follows the unchannelized and meandering Salt Creek for seven miles, and mostly consists of mature floodplain hardwoods. There are park species checklists of nearly 200 birds, 443 plants and 60 butterflies. The bird list includes 37 water-dependent species in addition to many floodplain forest species. Located along Salt Creek, off U.S. Highway 77, from West Van Dorn south to Saltillo Road. . A Lincoln municipal park, free admission (Ph. 402/441-7895).

Yankee Hill Lake WMA. Area 728 acres. A 210-acre reservoir surrounded with grassland and wooded bottomlands. Located on Cardwell Branch Creek (a tributary to Salt Creek), three miles east and one mile south of Denton. Lat./Long. 40.7248/-96.78885. URL: http://www.ngpc.state.ne.us/parks/guides/parksearch/showpark.asp?Area_No=49

SAUNDERS COUNTY

Saunders County is a Platte River valley county, with over 4,000 acres of surface water, including important saline wetlands on tributaries of Rock Creek

along the Lancaster County line. The county's area is 754 square miles (averaging 26.9 people per square mile). It contains one state recreation area, two wildlife management areas, and its northern and eastern boundaries are formed by the Platte River.

Jack Sinn Memorial WMA. See Lancaster County.

Table 14

Wetland Birds of Lincoln's Historic Salt Basin (Capitol Beach)*

Species
Greater White-fronted Goose. Rare
Snow Goose. Common
Canada Goose. Common
Trumpeter Swan. Rare
Tundra Swan. Rare
Wood Duck. Frequent
Gadwall. Common
American Wigeon. Uncommon
American Black Duck. Uncommon
Mallard. Common
Blue-winged Teal. Common
Cinnamon Teal. Very rare
Northern Shoveler. Common
Northern Pintail. Common
Green-winged Teal. Common
Canvasback. Frequent
Redhead. Frequent
Ring-necked Duck. Very rare
Lesser Scaup. Frequent
Surf Scoter. Rare
White-winged Scoter. Rare
Black Scoter. Very rare
Bufflehead. Common
Common Goldeneye. Very rare
Hooded Merganser. Frequent
Red-breasted Merganser. Rare
Common Merganser. Rare
Ruddy Duck. Common
Common Loon. Uncommon
Pied-billed Grebe. Common
Horned Grebe. Frequent
American White Pelican. Frequent
Double-crested Cormorant. Rare
American Bittern. Common
Least Bittern. Rare
Great Blue Heron. Uncommon
Snowy Egret. Rare
Little Blue Heron. Rare
Green Heron. Common
Black-crowned Night-Heron. Common
Virginia Rail. Common
American Coot. Common
Sandhill Crane. Rare
Whooping Crane. Rare
Black-bellied Plover. Uncommon
American Golden-Plover. Frequent
Semipalmated Plover. Common
Piping Plover. Rare
Killdeer. Common
American Avocet. Uncommon
Spotted Sandpiper. Uncommon
Solitary Sandpiper. Frequent
Greater Yellowlegs. Uncommon
Willet. Infrequent
Lesser Yellowlegs. Common
Upland Sandpiper. Frequent
Hudsonian Godwit Infrequent
Marbled Godwit. Infrequent
Ruddy Turnstone. Very rare
Red Knot. Very rare
Sanderling. Rare
Semipalmated Sandpiper. Recorded
White-rumped Sandpiper. Common
Baird's Sandpiper. Very common
Pectoral Sandpiper. Uncommon
Dunlin. Very rare
Stilt Sandpiper. Uncommon
Buff-breasted Sandpiper. Uncommon
Short-billed Dowitcher. Infrequent
Long-billed Dowitcher. Infrequent
Wilson's Snipe. Common
Wilson's Phalarope. Common
Red-necked Phalarope. Uncommon
Pomarine Jaeger. Very rare
Franklin's Gull. Common
Bonaparte's Gull. Uncommon
Ring-billed Gull. Uncommon
Herring Gull. Rare
Caspian Tern. Very rare
Common Tern. Uncommon
Forster's Tern. Uncommon
Least Tern. Uncommon
Black Tern. Common

*Based on Hunter (1900), with names and taxonomy updated. Ducey (1985) reported that 230 bird species had been documented on eastern Nebraska saline wetlands since 1900.

Vegetation of the Eastern Nebraska Saline Wetlands

Plant Communities

(with mean soil/water pH values and mean percentage total salts**)

Broad-leaf cattail community. 6.2–7.4, 0.0%
Prairie bulrush community. 6.1–6.8, 0.1%
Prairie–Inland salt grass community. 7.5–8.2, 0.1%
Wigeongrass–Sago pondweed community. 6.6–8.2, 0.3%
Inland saltgrass community. 7.3–8.7, 0.6%
Foxtail barley–Marsh-elder community. 7.0–8.2, 0.7%
Saltwort community. 7.0–9.0, 1.6%
Sea blite community. 7.1–7.9, 3.7%
Dwarf inland salt grass community. 7.5–8.0, 4.2%

Indicator Species*
- Spearscale. *Atriplex subspicata*
- Prairie bulrush. *Bolboschoenus (Scirpus) maritimus* var. *paludosus*
- Inland salt grass. *Distichlis spicata* var. *stricta*
- Saltwort. *Salicornia rubra*
- Sea blite. *Sueda depressa*
- Narrow-leaved cattail. Typha angustifolia

Rare Species*
- Saltmarsh aster. *Aster subulatus* var. *lingulatus*
- Seaside heliotrope. *Heliotropium curassivicum* var. *curassivicum*
- Saltwort. *Salicornia rubra*. **Endangered in Nebraska.**
- Texas dropseed. *Sporobolus texanus*

Peripheral Species**
- Common ragweed. *Abrosia artemisiifolia*
- Yarrow. *Achillea millefolium*
- Western wheatgrass. *Agropyron smithii*
- Smooth brome. *Bromus inermus*
- Japanese brome. *Bromus japonicus*
- Snow-on-the-mountain. *Euphorbia marginata*
- Common sunflower. *Helianthus annuus*
- Kochia. *Kochia scoparia*
- Pepper-grass. *Lepidium virginicum*
- White sweet-clover. *Melilotis alba*
- Yellow sweet-clover. *Melilotis officinale*
- Pale dock. *Rumex altissima*
- Curly dock. *Rumex crispus*
- Common threesquare. *Schoenoplectus pungens (= Scirpus americanus)*
- Rough dropseed. *Sporobolus compositus (asper)*
- Hoary vervain. *Verbena stricta*

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* Data of Gersib & Steinauer, 1991
** Data of Ungar, Hogan & McClelland, 1969

Appendix 1

Mammals of Nebraska's Wetlands

About 35 species of Nebraska's more obviously water-dependent forms are included here, as well as those of the state's riparian woods and moist meadows. The important mammals of the northern Great Plains prairie wetlands were identified by Fritzell (1989); these species are marked with asterisks in the following list. Descriptions, range maps and illustrations of all Nebraska's mammals are provided by Kays and Wilson (2002). Some non-wetland species mentioned in this book are not included in this table; they are referred to using nomenclature of Kays and Wilson. Familial and generic sequences are arranged in traditional taxonomic sequence; species are listed alphabetically within genera.

Family Soricidae–Shrews

Masked shrew. *Sorex cinereus.* Locally common (especially north, rare in southern counties), mainly in moist grasslands or somewhat brushy to wooded mesic habitats. Increasing southwardly.*

Northern short-tailed shrew. *Blarina brevicauda.* Common (north); diverse habitats.

Elliot's short-tailed shrew. *Blarina hylophaga.* Common (south); diverse habitats.

Least shrew. *Cryptotis parva.* Uncommon (east & central, rare in Panhandle). Open grassy or weedy habitats, especially moist prairies.

Family Talpidae – Moles

Eastern mole. *Scalopus aquaticus.* Widespread; mostly subterranean, loamy soils and taller grasses.

Family Leporidae–Hares and Rabbits

Eastern cottontail. *Sylvilagus floridanus.* Widespread; riparian woods and taller grasslands.

Family Sciuridae–Squirrels

Woodchuck. *Marmota monax.* East and central; deciduous riparian woods.

Franklin's ground squirrel. *Spermophilus franklini.* East and central; forest edges, tallgrass prairies and meadows.*

Thirteen-lined ground squirrel. *Spermophilus tridecemlineatus.* Widespread; especially in mixed-grass prairies.*

Fox squirrel. *Sciurus niger.* East and northwest; deciduous riparian woods.

Family Geomyidae--Pocket Gophers

Plains pocket gopher. *Geomys bursarius.* Widespread; especially in moist grasslands.

Family Castoridae–Beavers

Beaver. *Castor canadensis.* Widespread in aquatic habitats.*

Family Muridae– Rats and Mice

Western harvest mouse. *Reithrodontomys megalotis.* Widespread; taller moist grasslands.*

White-footed mouse. *Peromyscus leucopus.* Mainly east and central; all habitats.

Deer mouse. *Peromyscus maniculatus.* Widespread; all open habitats.*

Hispid cotton rat. *Sigmodon hispidus.* Southeast and southcentral only; dense herbaceous vegetation and moist grasslands.

Southern bog lemming. *Synaptomys cooperi.* East and central; also southwest; fen-like grassy habitats.

Prairie vole. *Microtus ochrogaster.* Widespread; taller grasslands.

Meadow vole. *Microtus pernnsylvanicus.* Widespread; increasing southwardly, moist grasslands.*

Woodland vole. *Microtus pinetorum.* Southeast and Missouri Valley; wooded habitats.

Muskrat. *Ondatra zibethicus.* Widespread in aquatic habitats.*

Family Zapodidae–Jumping Mice

Meadow jumping mouse. *Zapus hudsonius.* East and central; grassy or herbaceous habitats.*

Family Canidae-Coyotes, Wolves and Foxes
Coyote. *Canis latrans.* Widespread; especially in grasslands.
Red fox. *Vulpes vulpes.* Widespread; especially near riparian woods.*

Family Procyonidae–Raccoons and Allies
Raccoon. *Procyon lotor.* Statewide; near trees and along rivers.*

Family Mustelidae–Weasels, Badgers, Skunks and Otters
Long-tailed weasel. *Mustela frenata.* Statewide; grasslands and woods. *
Least weasel. *Mustela nivalis.* Statewide; diverse habitats.*
Mink. *Mustela vison.* Statewide; near rivers and marshes.*
Striped skunk. *Mephitis mephitis.* Statewide; diverse habitats.*
Northern river otter. *Lutra canadensis.* Rare; reintroduced in some rivers. **State threatened.**
Nebraska Tier 1 At-list species.

Family Cervidae–Deer, Elk and Moose
White-tailed deer, *Odocoileus virginianus.* Widespread.*

Appendix 2

Birds of Nebraska's Wetlands and Riverine Woods

The following list of 124 primarily aquatic and wetland-dependent or wetland-associated species (including 67 breeders) is followed by a list of 107 species variably associated with floodplain forests and riverine scrub woodlands (including 75 breeders) in Nebraska. Together, these 231 species represent nearly two-thirds of the 360 regularly occurring birds of Nebraska, and also about two-thirds of Nebraska's approximately 210 breeding species, indicating the very high value of Nebraska's wetlands to its avifauna relative to its geographic area. Numbers following status statements are the total number of breeding-season encounters during the 1984–1989 Breeding Bird Atlas surveys (Mollhoff, 2000). Asterisks indicate known current or recent breeding species; Tier-1 At-risk species are those considered to be at greatest risk of extinction by the Nebraska Natural Legacy Project (Panella, 2010). Taxonomic sequence as well as common and Latin names follow the most recent American Ornithologists' Union list. Rare and accidental species are excluded.

TYPICAL WETLAND SPECIES

Family Anatidae – Swans, Geese & Ducks

Greater white-fronted goose. *Anser albifrons.* Common migrant.
Snow goose. *Chen caerulescens.* Abundant migrant.
Ross's goose. *Chen rossii.* Uncommon migrant.
Canada goose. *Branta canadensis.* Common summer resident; uncommon wintering resident.* 48
Cackling goose. *Branta hutchinsii.* Common migrant.
Trumpeter swan. *Cygnus buccinator.* Occasional migrant (east); local permanent resident (Sandhills) Tier-1 At-risk species.* 9
Tundra swan. *Cygnus columbianus.* Occasional migrant (mainly east).
Wood duck. *Aix sponsa.* Common summer resident (mainly east).*195
Gadwall. *Anas strepera.* Common summer resident.* 43
American wigeon. *Anas americana.* Common summer resident.* 19
American black duck. *Anas rubripes.* Occasional migrant (east).
Mallard *Anas platyrhynchos.* Common summer resident; uncommon wintering resident.* 250
Blue-winged teal. *Anas discors.* Common summer resident.* 157
Cinnamon teal. *Anas cyanoptera.* Regular summer resident (west).* 9
Northern shoveler. *Anas clypeata.* Common summer resident.* 62
Northern pintail. *Anas acuta.* Common summer resident.* 78
Green-winged teal. *Anas crecca.* Common summer resident.* 41
Canvasback. *Aythya valisineria.* Uncommon summer resident.* 11
Redhead. *Aythya americana.* Common summer resident.* 41
Ring-necked duck. *Aythya collaris.* Common migrant, historic summer resident.
Greater scaup. *Aythya marila.* Uncommon to rare migrant.
Lesser scaup. *Aythya affinis.* Common migrant. possible rare summer resident (central).
Surf scoter. *Melanitta perspicillata.* Uncommon migrant.
White-winged scoter. *Melanitta fusca.* Uncommon migrant.
Black scoter. *Melanitta americana.* Occasional migrant.
Long-tailed duck. *Clangula hyemalis.* Uncommon migrant.
Bufflehead. *Bucephala albeola.* Common migrant.
Common goldeneye. *Bucephala clangula.* Common migrant.
Barrow's goldeneye. *Bucephala islandica.* Occasional migrant.
Hooded merganser. *Lophodytes cucullatus.* Regular migrant. casual summer resident.*
Red-breasted merganser. *Mergus serrator.* Regular migrant.
Common merganser. *Mergus merganser.* Common migrant. casual summer resident.*
Ruddy duck. *Oxyura jamaicensis.* Common summer resident (central & west).* 39

Family Phasianidae – Pheasants, Grouse & Partridges

Greater prairie-chicken. *Tympanuchus cupido.* Uncommon permanent resident.* Considered a tall-grass species in eastern Nebraska and a wet-meadow species in central and western Nebraska. Tier-1 At-risk species. 52.

Family Gaviidae – Loons
Common loon. *Gavia immer.* Common migrant.

Family Podicipedidae – Grebes
Pied-billed grebe. *Podilymbus podiceps.* Common summer resident.* 58
Horned grebe. *Podiceps auritus.* Regular migrant, possible rare breeder.
Eared grebe. *Podiceps nigricollis.* Common summer resident (west).* 34
Western grebe. *Aechmophorus occidentalis.* Common summer resident (central & west).* 33
Clark's grebe. *Aechmophorus clarkii.* Regular summer resident (west).*

Family Pelecanidae – Pelicans
American white pelican. *Pelecanus erythrorhynchos.* Common non-breeding summer resident.

Family Phalacrocoracidae – Cormorants
Double-crested cormorant. *Phalacrocorax auritus.* Common summer resident.* 46

Family Ardeidae – Bitterns and Herons
American bittern. *Botaurus lentiginosus.* Common summer resident.* 38
Least bittern. *Ixobrychus exilis.* Uncommon summer resident.* 12
Great blue heron. *Ardea herodias.* Common summer resident.* 215
Great egret. *Ardea alba.* Regular non-breeding summer resident, possible rare breeder.
Snowy egret. *Egretta thula.* Irregular summer resident, rare breeder.* 4
Little blue heron. *Egretta caerulea.* Irregular non-breeding summer resident.
Cattle egret. *Bubulcus ibis.* Regular summer resident, rare breeder.* 13
Green heron. *Butorides virescens.* Common summer resident.* 83
Black-crowned night-heron. *Nycticorax nycticorax.* Common summer resident.* 36

Family Threskiornithidae – Ibises and Spoonbills
White-faced ibis. *Plegadis chihi.* Local summer resident (west).* 1

Family Accipitridae Kites, Hawks, Eagles & Allies
Northern harrier. *Circus cyaneus.* Regular summer resident.* 66

Family Rallidae – Rails, Gallinules & Coots
King rail. *Rallus elegans.* Occasional summer resident (east). Tier-1 At-risk species.*
Virginia rail. *Rallus limicola.* Regular summer resident.* 21
Sora. *Porzana carolina.* Common summer resident.* 23
Common moorhen. *Gallinula chloropus.* Occasional summer resident (east).* 3
American coot. *Fulica americana.* Common summer resident.* 92

Family Gruidae – Cranes
Sandhill crane. *Grus canadensis.* Common migrant; very rare summer resident.*
Whooping crane. *Grus americana.* Regular migrant (central). **Nationally endangered.** Tier-1 At-risk species.

Family Charadriidae – Plovers
Black-bellied plover. *Pluvialis squatarola.* Regular migrant.
American golden-plover. *Pluvialis dominica.* Regular migrant.
Snowy plover. *Charadrius alexandrinus.* Occasional migrant; rare breeder.*
Semipalmated plover. *Charadrius semipalmatus.* Regular migrant.
Piping plover. *Charadrius melodus.* Regular summer resident. **Nationally threatened.** Tier-1 At-risk species.* 31
Killdeer. *Charadrius vociferus.* Common summer resident* 387

Family Recurvirostridae – Stilts and Avocets
Black-necked stilt. *Himantopus mexicanus.* Local summer resident (west).* 2
American avocet. *Recurvirostra americana.* Regular summer resident (central & west).* 30

Family Scolopacidae – Sandpipers and Phalaropes
Spotted sandpiper. *Actitis macularia.* Common summer resident.* 126
Solitary sandpiper. Tringa solitaria. Regular migrant.
Greater yellowlegs. *Tringa melanoleuca.* Common migrant.
Willet. *Tringa semipalmatus.* Regular summer resident (central & west).* 33
Lesser yellowlegs. *Tringa flavipes.* Common migrant.

Upland sandpiper. *Bartramia longicauda.* Common summer resident.* 234
Whimbrel. *Numenius phaeopus.* Occasional migrant.
Long-billed curlew. *Numenius americanus.* Uncommon summer resident (central & west).* Tier-1 At-risk species. 69
Hudsonian godwit. *Limosa haemastica.* Uncommon migrant (east).
Marbled godwit. *Limosa fedoa.* Uncommon migrant; probable rare summer resident (northwest).*
Ruddy turnstone. *Arenaria interpres.* Occasional migrant (east).
Red knot. *Calidris canutus.* Occasional migrant (east).
Sanderling. *Calidris alba.* Regular migrant.
Semipalmated sandpiper. *Calidris pusilla.* Regular migrant.
Western sandpiper. *Calidris mauri.* Regular migrant (mainly west).
Least sandpiper. *Calidris minutilla.* Common migrant.
White-rumped sandpiper. *Calidris fuscicollis.* Common migrant, mainly in spring.
Baird's sandpiper. *Calidris bairdii.* Common migrant.
Pectoral sandpiper. *Calidris melanotos.* Common migrant.
Dunlin. *Calidris alpina.* Regular migrant (east).
Stilt sandpiper. *Calidris himantopus.* Common migrant.
Buff-breasted sandpiper. *Tryngites subruficollis.* Regular migrant (east). Tier-1 At-risk species.
Short-billed dowitcher. *Limnodromus griseus.* Occasional migrant (east).
Long-billed dowitcher. *Limnodromus scolopaceus.* Common migrant.
Wilson's snipe. *Gallinago delicata.* Regular local summer resident.* 40
American woodcock. *Scolopax minor.* Regular summer resident (east and central).* 15
Wilson's phalarope. *Phalaropus tricolor.* Regular summer resident (west and central).* 76
Red-necked phalarope. *Phalaropus lobatus.* Regular migrant.
Red phalarope. *Phalaropus fulicaria.* Occasional migrant.

Family Laridae – Gulls and Terns
Bonaparte's gull. *Chroicocephalis philadelphia.* Regular migrant.
Franklin's gull. *Leucophaes pipixcan.* Common migrant.
Ring-billed gull. *Larus delawarensis.* Common non-breeding resident.
California gull. *Larus californicus.* Regular migrant (west).
Herring gull. *Larus argentatus.* Regular non-breeding resident.
Glaucous gull. *Larus hyperboreus.* Regular migrant (mainly west).
Caspian tern. *Sterna caspia.* Regular migrant (east). uncommon summer nonbreeder (west).
Common tern. *Sterna hirundo.* Regular migrant (east).
Forster's tern. *Sterna forsteri.* Regular summer resident (west and central).* 18
Interior least tern. *Sterna antillarum athalassos.* Regular summer resident (east to west-central).* **Nationally endangered.** Tier-1 At-risk species.
Black tern. *Chlidonias niger.* Regular summer resident (west and central).* 68

Family Strigidae – Typical Owls
Short-eared owl. *Asio flameus.* Uncommon resident.* 6

Family Alcedinidae – Kingfishers
Belted kingfisher. *Ceryle alcyon.* Regular summer resident.* 198

Family Hirundinidae – Swallows
Northern rough-winged swallow. *Stelgidopteryx serripennis.* Common summer resident.* 311
Bank swallow. *Riparia riparia.* Common summer resident.* 87
Cliff swallow. *Petrochelidon pyrrhonota.* Common summer resident.* 194
Barn swallow. *Hirundo rustica.* Common summer resident.* 433

Family Troglodytidae – Wrens
Sedge wren. *Cistothorus platensis.* Regular summer resident (east).* 18
Marsh wren. *Cistothorus palustris.* Regular summer resident.* 50

Family Motacillidae – Pipits
American pipit. *Anthus rubescens.* Regular migrant.

Family Parulidae – Wood Warblers
Common yellowthroat. *Geothlypis trichas.* Common summer resident.* 340

Family Emberizidae – Towhees & Sparrows

Savannah sparrow. *Passerculus sandwichensis.* Very local summer resident (west).*
Swamp sparrow. *Melospiza georgiana.* Regular summer resident (east and central).* 31
Dickcissel. *Spiza americana.* Commoon summer resident * 305

Family Icteridae –Blackbirds, Meadowlarks & Orioles

Bobolink. *Dolichonyx oryzivorus.* Regular summer resident.* 133
Red-winged blackbird. *Agelaius phoeniceus.* Common summer resident.* 422
Eastern meadowlark. *Sturnella magna.* Common summer resident.* Considered a tall-grass species in eastern Nebraska and a wet-meadow species in central and western Nebraska. 101.
Yellow-headed blackbird. *Xanthocephalus xanthocephalus.* Common summer resident.* 117
Rusty blackbird. *Euphagus carolinus.* Regular migrant.
Great-tailed grackle. *Quiscalus mexicanus.* Common summer resident (east and central).* 15

FLOODPLAIN FOREST AND RIVERINE SCRUB SPECIES

Family Accipitridae Kites, Hawks, Eagles & Allies

Osprey. *Pandion haliaetus.* Regular migrant; very rare breeder.*
Bald eagle. *Haliaeetus leucocephalus.* Regular overwintering migrant, local resident. Tier-1 At-risk species.*
Sharp-shinned hawk. *Accipiter striatus.* Common migrant; rare summer resident (north).* 7.
Cooper's hawk. *Accipiter cooperii.* Uncommon resident.* 19
Red-tailed hawk. *Buteo jamaicensis.* Common resident.* 249
American kestrel. *Falco sparverius.* Common resident.* 255.

Family Cuculidae – Cuckoos and Anis

Yellow-billed cuckoo. *Coccyzus americanus.* Uncommon summer resident.* 198
Black-billed cuckoo. *Coccyzus erythropthalmus.* Occasional summer resident.* 102

Family Strigidae – Typical Owls

Eastern screech-owl. *Megascops asio.* Uncommon resident.* 118
Great horned owl. *Bubo virginianus.* Uncommon resident.* 222
Barred owl. *Strix varia.* Uncommon resident (east).* 19
Long-eared owl. *Asio otus.* Uncommon resident.* 7

Family Caprimulgidae – Goatsuckers

Chuck-will's-widow. *Caprimulgus carolinensis.* Uncommon summer resident (east).* 8
Whip-poor-will. *Caprimulgus vociferus.* Uncommon summer resident (southeast).* 22

Family Trochilidae – Hummingbirds

Ruby-throated hummingbird. *Archilochus colubris.* Uncommon summer resident (east).* 11

Family Picidae – Woodpeckers

Red-headed woodpecker. *Melanerpes erythrocephalus.* Common summer resident.* 357
Red-bellied woodpecker. *Melanerpes carolinus.* Common resident (east).* 109
Yellow-bellied sapsucker. *Sphyrapicus varius.* Uncommon migrant.
Downy woodpecker. *Picoides pubescens.* Common resident.* 248
Hairy woodpecker. *Picoides villosus.* Common resident.*102
Northern flicker. *Colaptes auratus.* Common resident.* 335

Family Tyrannidae – Tyrant Flycatchers

Olive-sided flycatcher. *Contopus cooperi.* Uncommon migrant (east)
Western wood-pewee. *Contopus sordidulus.* Uncommon summer resident (east).* 39
Eastern wood-pewee. *Contopus virens.* Uncommon summer resident (west).* 103
Yellow-bellied flycatcher. *Empidonax flaviventris.* Uncommon migrant (east)
Acadian flycatcher. *Empidonax virescens.* Uncommon migrant, possible local summer resident (east)
Willow flycatcher. *Empidonax traillii.* Uncommon summer resident (east).* 45
Least flycatcher. *Empidonax minimus.* Uncommon migrant (east), local summer residient (northeast).*.
Eastern phoebe. *Sayornis phoebe.* Uncommon summer resident (east).* 136
Say's phoebe. *Sayornis saya.* Uncommon summer resident (west).* 50
Great crested flycatcher. *Myiarchus crinitus.* Uncommon summer resident (east).* 157

Family Vireonidae – Vireos

White-eyed vireo. *Vireo griseus.* Probable local summer resident (southeast).

Bell's vireo. *Vireo bellii.* Regular summer resident.* Tier-1 At-risk species. 133
Blue-headed vireo. *Vireo solitarius.* Uncommon migrant (east)
Yellow-throated vireo. *Vireo flavifrons.* Uncommon or local summer resident (east).* 11
Warbling vireo. *Vireo gilvus.* Common summer resident.* 266
Philadelphia vireo. *Vireo philadelphicus.* Uncommon migrant (east)
Red-eyed vireo. *Vireo olivaceus.* Common summer resident (east).* 82

Family Corvidae – Jays, Magpie and Crows
Blue jay. *Cyanocitta cristata.* Common resident.* 333
American crow. *Corvus brachyrhynchos.* Common resident.* 288.

Family Alaudidae Larks
Horned lark. *Eremophila alpestris.* Common resident.* 261

Family Hirundinidae – Swallows
Purple martin. *Progne subis.* Common summer resident (east).* 59
Violet-green swallow. *Tachycineta thalassinia.* Local summer resident (northwest).* 11

Family Paridae – Titmice
Black-capped chickadee. *Poecile atricapillus.* Common resident.* 277
Tufted titmouse. *Baeolophus bicolor.* Uncommon resident (southeast).* 18

Family Sittidae – Nuthatches
White-breasted nuthatch. *Sitta carolinensis.* Common resident.* 160

Family Certhiidae – Creepers
Brown creeper. *Certhia americana.* Uncommon resident.*

Family Troglodytidae – Wrens
Carolina wren. *Thryothorus ludovicianus.* Uncommon resident (southeast).* 5
House wren. *Troglodytes aedon.* Common resident.* 342

Family Regulidae – Kinglets
Golden-crowned kinglet. *Regulus satrapa.* Common migrant
Ruby-crowned kinglet. *Regulus calendula.* Common migrant

Family Sylviidae – Gnatcatchers
Blue-gray gnatcatcher. *Polioptila caerulea.* Uncommon resident (east & Panhandle).* 16

Family Turdidae – Thrushes
Eastern bluebird. *Sialia sialis.* Common resident (east).* 145
Mountain bluebird. *Sialia currucoides.* Uncommon summer resident (Panhandle)* 16
Veery. *Catharus fuscescens.* Uncommon to rare migrant.
Gray-cheeked thrush. *Catharus minimus.* Uncommon migrant (east).
Swainson's thrush. *Catharus ustulatus.* Common migrant, rare summer resident (northwest).
Hermit thrush. *Catharus guttatus.* Uncommon migrant (east)
Wood thrush. *Hylocichla mustelina.* Uncommon migrant (east), local summer resident (north)* 44
American robin. *Turdus migratorius.* Common resident.* 393

Family Mimidae – Mockingbirds, Thrashers & Catbirds
Gray catbird. *Dumetella carolinensis.* Common summer resident (east).* 228
Northern mockingbird. *Mimus polyglottos.* Uncommon summer resident (south)* 61
Brown thrasher. *Toxostoma rufum.* Common summer resident (east).* 364

Family Sturnidae – Starlings
European starling. *Sturnus vulgaris.* Abundant resident.* 336

Family Bombycillidae – Waxwings
Cedar waxwing. *Bombycilla cedrorum.* Common summer resident.* 67

Family Parulidae – Wood Warblers

Tennessee warbler. *Vermivora peregrina.* Common migrant.
Orange-crowned warbler. *Vermivora celata.* Common migrant.
Nashville warbler. *Vermivora ruficapilla.* Common migrant.
Northern parula. *Parula americana.* Uncommon migrant, local summer resident (east).*
Yellow warbler. *Dendroica petechia.* Common summer resident.* 280
Chestnut-sided warbler. *Dendroica pensylvanica.* Uncommon migrant (east).
Magnolia warbler. *Dendroica magnolia.* Uncommon migrant (east).
Cape May warbler. *Dendroica tigrina.* Uncommon migrant (east).
Yellow-rumped warbler. *Dendroica coronata.* Common migrant, local summer resident (Panhandle).* 11
Cerulean warbler. *Dendroica ceruleta.* Common migrant, extremely rare summer resident.* 4
Black-throated green-warbler. *Dendroica virens.* Uncommon migrant (east).
Blackburnian warbler. *Dendroica fusca.* Uncommon migrant (east).
Yellow-throated warbler. *Dendroica dominica.* Uncommon migrant, local summer resident (east).*
Bay-breasted warbler. *Dendroica castanea.* Uncommon migrant (east).
Blackpoll warbler. *Dendroica striata.* Uncommon migrant (east).
Black-and-white warbler. *Mniotilta varia.* Uncommon migrant (east), local summer resident (northwest).*. 14
American redstart. *Setophaga ruticilla.* Uncommon migrant (east); local summer resident (north & east)*. 36
Prothonotary warbler. *Protonotaria citrea.* Local summer resident (southeast.) * 7
Ovenbird. *Seiurus aurocapillus.* Uncommon migrant; local summer resident (east)* 27
Northern waterthrush. *Parkesia noveboracensis.* Uncommon migrant (east).
Louisiana waterthrush. *Parkesia motacilla.* Uncommon migrant; rare summer resident (east).* 4
Kentucky warbler. *Oporornis formosus.* Uncommon migrant (east); local summer resident (east)* 9
Mourning warbler. *Oporornis philadelphia.* Uncommon migrant (east).
Wilson's warbler. *Wilsonia pusilla.* Common migrant (east).
Canada warbler. *Wilsonia canadensis.* Uncommon migrant (east).
Yellow-breasted chat. *Icteria virens.* Uncommon migrant, local summer resident (west).* 67

Family Emberizidae – Towhees & Sparrows

Eastern towhee. *Pipilo erythrophthalmus.* Common summer resident (east).* 144 (including spotted towhee)
Spotted towhee. *Pipilo maculatus.* Common summer resident (west).*
Chipping sparrow. *Spizella passerina.* Common summer resident.* 135
Fox sparrow. *Passerella iliaca.* Common migrant (east).
Song sparrow. *Melospiza melodia.* Common summer resident.* 85

Family Cardinalidae – Tanagers, Cardinals & Grosbeaks

Summer tanager. *Piranga rubra.* Uncommon summer resident (east).* 7
Scarlet tanager. *Piranga olivacea.* Uncommon summer resident (east).* 18
Western tanager. *Piranga ludoviciana.* Uncommon summer resident (west).* 12
Northern cardinal. *Cardinalis cardinalis.* Common resident (east).* 204
Rose-breasted grosbeak. *Pheucticus ludovicianus.* Common summer resident (east).* 135
Black-headed grosbeak. *Pheucticus melanocephalus.* Uncommon summer resident (west).* 52
Blue grosbeak. *Passerina caerulea.* Uncommon summer resident (west).* 152
Lazuli bunting. *Passerina amoena.* Uncommon summer resident (west).* 22
Indigo bunting. *Passerina cyanea.* Uncommon summer resident (east).* 179

Family Icteridae – Blackbirds. Orioles. etc

Common grackle. *Quiscalus quiscula.* Common summer resident.* 410
Brown-headed cowbird. *Molothrus ater.* Common summer resident.* 406
Orchard oriole. *Icterus spurius.* Common summer resident.* 355
Baltimore oriole. *Icterus galbula.* Common summer resident (east).* 339
Bullock's oriole. *Icterus bullockii.* Common summer resident (west).* 48

Family Fringillidae – Finches

Purple finch. *Carpodacus purpureus.* Uncommon migrant.
House finch. *Carpodacus mexicanus.* Common summer resident.* 37

Appendix 3

Reptiles and Amphibians of Nebraska's Wetlands

This list of about 30 species is mainly based on those of Lynch (1985) and Fogell (2010), with the Latin and English names based on Fogell. All Nebraska species are described, mapped and illustrated in the field guide by Fogell (2010). Some non-wetland species mentioned in this book are not listed in this table; they are referred to by using Fogell's nomenclature. Identification keys to all Nebraska's herps may be found in that reference. Species reported from Bader Park and Mormon Island in the Platte River valley (Whitney & Whitney, 1987) are indicated by asterisks. Freeman (1989) associated five amphibians, five turtles and two snakes species with aquatic habitats in the Sandhills.

Order Caudata–Salamanders

Small-mouth salamander. *Ambystoma texanum.* Southeast; rare in ponds.
Barred tiger salamander. *Ambystoma mavortium.* Widespread; common in shallow ponds.
Eastern tiger salamander. *Ambystoma tigrinum.* Widespread; common in shallow ponds.

Order Anura–Frogs and Toads

Blanchard's cricket frog. *Acris blanchardi.* Eastern; common in streams and ponds.
American toad. *Anaxyrus americanus.* Missouri Valley; local and probably rare, grasslands.
Great Plains toad. *Anaxyrus cognatus.* Widespread, fairly common in grasslands.
Woodhouse's (Rocky Mountain) toad. *Anaxyrus woodhousii.* Statewide, common in grasslands and forest edges.*
Gray treefrog. *Hyla chrysocelis.* Southeast, in wooded and temporary ponds.
Plains leopard frog. *Lithobates blairi.* Eastern half and southwest, in permanent waters.*
Bullfrog. *Lithobates catesbiana.* Widespread in aquatic habitats. In invasine species.*
Northern leopard frog. *Lithobates pipiens.* Widespread from Platte north, in sandy streams and marshes.
Boreal chorus frog. *Pseudacris maculata.* Widespread, common in ditches and marshes.*
Plains spadefoot toad. *Spea bombifrons.* Widespread, temporary ponds in sandy or loess soils.*

Order Chelonia–Turtles

Smooth softshell. *Apalone muticus.* Larger eastern rivers.*
Spiny softshell. *Apalone spiniferus.* Widespread in larger rivers and reservoirs.*
Snapping turtle. *Chelydra serpentina.* Widespread in permanent water habitats.*
Painted turtle. *Chrysemys picta.* Widespread in all aquatic habitats.*
Blanding's turtle. *Emydoidea blandingii.* From Platte north, mostly limited to Sandhills marshes. Nebraska Tier 1 At-list species.
False map turtle. *Graptemys pseudogeographica.* Missouri River and adjoining oxbows.
Yellow mud turtle. *Kinosternum flavescens.* Republican River and Sandhills ponds and lakes.

Order Serpentes–Snakes

Timber rattlesnake. *Crotalus horridus.* Southeastern, in wooded habitats near streams; venomous. Nebraska Tier 1 At-list species.
Smooth green snake. *Liochlorophis vernalis.* Local central Platte Valley marshes and wet meadows..
Western fox snake. *Mintonius vulpinus.* Northeastern an eastern, mostly near streams.
Northern watersnake. *Nerodia sipedon.* Widespread, in marshes, streams and rivers.
Graham's crayfish snake. *Regina grahamii.* Eastern and southeastern; rare in streams and lakes.
Massasauga. *Sistrurus catenatus.* Southeastern, wet prairies; venomous. State threatened. Nebraska Tier 1 At-list species.
Texas brown (DeKay's) snake. *Storeria dekayi.* Southeastern, in moist woods.
Redbelly snake. *Storeria occipitomaculata.* Local in central Platte Valley wet meadows.
Terrestrial garter snake. *Thamnophis elegans.* Extreme northwest, diverse habitats, often near streams.
Western ribbon snake. *Thamnophis proximus.* Eastern, often near streams.
Plains garter snake. *Thamnophis radix.* Statewide, often near wetlands and streams.*
Common (red-sided) garter snake. *Thamnophis sirtalis parietalis.* Statewide, common along watercourses.*
Lined snake. *Tropidoclonion lineatum.* Local in Platte and lower Missouri valley in moist wetlands and streamsides.

Appendix 4

Native Fishes of Nebraska Wetlands and Rivers

This list of about 40 species is based mainly on Johnson (1942) and Jones (1963), but excludes all introduced species. Most of the listed species were illustrated in color by Tomelleri and Eberle (1990).The family sequence and Latin names used here are those of currently accepted taxonomy; genera and species are listed alphabetically. Primarily river-dwelling species are included in the list only if they also occur in standing-water habitats. Some non-wetland species mentioned in the book are not listed in this table; they are referred to by the vernacular names used by Johnsgard (2001). Species reported from the Platte Valley at Bader Park and/or Mormon Island (Whitney & Whitney, 1987) are indicated by # symbols. Species reported from the Missouri Valley at DeSoto Lake (DeSoto National Wildlife Refuge) are indicated by single asterisks (if naturally occurring), or by double asterisks (if stocked). Species reported from Sandhills lakes by McCarraher (1977) are shown by $ symbols. Species reported from an intermittent Platte River wetland by Goldowitz and Whiles (1999). are shown by $$ symbols, and those from a perennial Platte River wetland by ## symbols.

LIMITED TO RIVERS AND DEEPER LAKES

Family Acipenseridae–Sturgeons

Pallid sturgeon. *Scaphirhynchus albus.* Missouri and lower Platte rivers; limited to large, silty or sandy rivers. **Nationally endangered.** Nebraska Tier-1 At-risk species.

Family Lepisosteidae–Gars

Longnose gar. *Lepidosteus osseus.* Missouri & lower Platte rivers; favors slow rivers, oxbow lakes and reservoirs.
Shortnose gar. *Lepidosteus platyostomus.* Missouri & lower Platte rivers; favors muddy waters, oxbow lakes and reservoirs.#

Family Amiidae–Bowfins

Bowfin, *Amia calva.* Missouri River and oxbow lakes; favors swamps, oxbows and river backwaters.

Family Cyprinidae–Minnows

Emerald shiner, *Notropis atherinoides.* Eastern, in sandy rivers and reservoirs.

Family Catostomidae–Suckers

River carpsucker, *Carpoides carpio.* Widespread, in rivers and reservoirs; favors slow sandy rivers.#
Quillback, *Carpoides cyprinus.* Widespread, in rivers and reservoirs; favors larger, clear rivers.*#
White sucker. *Catostomus commersoni.* Widespread, in streams and cool lakes.
Smallmouth buffalo. *Ictiobus bubalus.* Eastern, in rivers, reservoirs and oxbows; favors clear, faster rivers.*
Bigmouth buffalo. *Ictiobus cyrpinellus.* Eastern, in streams, reservoirs, and oxbows; favors warm, sluggish waters and oxbows.*
Black buffalo. *Ictiobus niger.* Northern and eastern, in rivers and reservoirs; favors deeper flowing waters.

Family Hiodontidae – Mooneyes

Goldeye. *Hiodon alosoides.* Mostly in eastern rivers; favors quiet, turbid waters and shallow lakes.#

Family Serranidae (= Perichthyiidae)–Temperate Basses

White bass, *Roccus (Morone) chrysops.* Widespread, in larger streams, lakes and reservoirs; favors sandy or hard-bottom substrates.**#

Family Ictaluridae– Freshwater Catfish

Yellow bullhead, *Ictalurus natalis.* Eastern, in streams lakes and reservoirs; favors clear waters over sand, gravel or rocks.*
Channel catfish. *Ictalurus punctatus.* Widespread, in lakes, streams and reservoirs; favors flowing waters.*
Flathead catfish. *Pylodictus oliverius.* Southeastern, in streams, lakes and reservoirs; favors deep sluggish pools in rivers.

Family Centrarchidae–Sunfishes

Rock bass, *Ambloplites rupestris.* Widespread, larger streams and reservoirs; favors rocky ledges or pools with tangled roots.

Family Percidae–Perches
Yellow perch, *Perca flavescens.* Widespread but local in lakes; favors cooler waters.#$
Walleye, *Stizostedion vitreum.* Widespread, in larger lakes; favors cooler and deeper waters.**$
Iowa darter. *Poecilichthys exilis.* Widespread, in sandy streams; also in cool sandy or silty lakes.##

Family Sciaenidae– Freshwater Drums
Freshwater drum, *Aplodinotus grunniens.* Larger rivers and reservoirs; favors deeper waters.*#

VARIABLY PRESENT IN STREAMS, SHALLOW LAKES, PONDS AND MARSHES
Family Clupeidae–Herrings
Gizzard shad, Dorosoma cepedianum. Widespread, from deeper reservoirs to shallow lakes; favors slow streams and shallow, warm lakes.*#

Family Esocidae–Pikes
Grass pickerel, *Esox vermiculatus.* Northern, in streams and weedy lakes; favors shallow, weedy water. $
Northern pike, *Esox lucius.* Widespread, in lakes, streams and deeper marshes.*$

Family Cyprinidae–Minnows
Northern redbelly dace, *Chrosomus eos.* Rare, in creeks and boggy wetlands; state threatened. Nebraska Tier-1 At-risk species.
Brassy minnow. *Hybognathus hankinsoni.* Widespread. $$##
Golden shiner, *Notemigonus crysoleucus.* Widespread but local in lakes and ponds; favors clear and weedy water.*$
Red shiner, *Notropis lutrensis.* Widespread in creeks and ponds; often in turbid waters.
Fathead minnow, *Pimephales promelas* Widespread in lakes, ponds, muddy ponds and sandpits; favors silty pools and tolerates warm water.*#, ##,$,$$
Creek chub. *Semotilus atromaculatus.* Widespread in small, clear streams, sometimes in clear lakes. $$##

Family Cyprinodontidae – Killifish
Plains topminnow. *Fundulus sciadicus.* Widespread from Platte River north. $$##

Family Ictaluridae– Freshwater Catfish
Black bullhead, *Ictalurus melas.* Widespread, in muddy creeks, farm ponds, small lakes.*#$
Tadpole madtom, *Noturus gyrinus.* Local, in muddy creeks, oxbows, shallow lakes.

Family Gasterosteidae–Sticklebacks
Brook stickleback, *Eucalis inconstans.* Local, in Sandhills streams and boggy lakes.$$##

Family Centrarchidae–Sunfishes
Largemouth bass, *Micropterus salmoides.* Widespread, in rivers, reservoirs, lakes and farm ponds.**#.##$,$$
Green sunfish, *Lepomis cyanellus.* Widespread, in lakes, ponds, river edges.**#.##$
Pumpkinseed, *Lepomis gibbosis.* Local, in weedy ponds, lake edges.
Orange-spotted sunfish, *Lepomis humilis.* Widespread, in lakes and often turbid streams.#
Bluegill, *Lepomis macrochirus.* Widespread, in streams, lakes and farm ponds.#,##$
White crappie, *Pomoxis annularis.* Widespread, in streams, lakes and farm ponds.**#
Black crappie, *Pomoxis nigromaculatus.* Widespread, in cool streams, lakes and farm ponds.**#$

Appendix 5

Freshwater Mussels of Nebraska's Wetlands and Rivers

This list of 32 Nebraska bivalve mussels includes those species described and illustrated by Freeman and Perkins (1994) for the Platte River, plus additional species listed for the Platte and its tributaries by Hoke (1995), and Hoke's lists for the Nemaha (1996) and Elkhorn (1994) basins. Nearly all the mussels listed here were included in a survey of Missouri mussels by Oesch (1984). The list is sequenced alphabetically by genus and species.

Threeridge. Amblema plicata. Impoundments and rivers in eastern quarter of state. Nebraska Tier 1 At-list species.
Mucket. Actinonaias ligamentina carinata. Reported for the Elkhorn and Nemaha basins.
Three-ridge. Amblema p. plicata. Eastern quarter of state, in rivers and reservoirs. Reported for the Elkhorn and Nemaha basins.
Giant Floater. Anodontia g. grandis. Common in Platte, Elkhorn and Nemaha basins.
Paper Pond Shell. Anodontia imbecilis. Sandy or muddy lakes, Platte, Elkhorn and Nemaha basins.
Flat floater, Anodontia suborbiculata. Missouri River; ponds, lakes, and slow-moving streams. Nebraska Tier 1 At-list species.
Cylindrical Paper Shell. Anodontoides ferrusacianus. Reported for the Platte, Elkhorn and Nemaha basins.
Asiatic Clam. Corbicula fluminea. Exotic, invasive species, introduced locally in Platte and Missouri rivers.
Zebra Mussel. Dreissena polymorpha. Exotic invasive species, introduced into Lakr Offut, Air Fore Base.
Wabash Pig-toe. Fusconaia flava. Reported for the Platte, Elkhorn and Nemaha basins.
Plain Pocketbook. Lampsilis cardium. Larger rivers in eastern third of state. Nebraska Tier 1 At-list species.
Scaleshell. Leptodea leptodea. Possibly in upper reach of Missouri River. Nationally endangered. Nebraska Tier 1 At-list species.
Higgin's Eye. Lampsilis higginsii.Upper reaches of Missouri River. Nationally endangered. Nebraska Tier 1 At-list species.
Fat Mucket. Lampisilis radiata. Reported for the Platte, Elkhorn and Nemaha basins.
Fat Mucket. Lampisilis siliquoidea. Lakes and slow-moving streams, Missouri River, lower Elkhorn and saline wetlands. Nebraska Tier 1 At-list species.
Sand Shell. Lampisilis teres. Reported for the Platte, Elkhorn and Nemaha basins.
Pocketbook. Lampisilis ventricosa. Reported for the Platte, Elkhorn and Nemaha basins.
White Heel-splitter. Lasmigona complanata. Reported for Platte, Elkhorn and Nemaha basins.
Heel-splitter. Lasmagona compresa. Reported for the Elkhorn and Nemaha basins.
Fragile Heel-splitter. Leptodea fragilis. Local in Platte, Elkhorn and Nemaha basins.
Black Sand Shell. Ligumia recta. Reported for the Elkhorn and Nemaha basins.
Pondmussel. Ligumia subrostrata. Eastern third of state (Platte, Elkhorn and Nemaha basins); ponds and creeks with muddy bottoms. Nebraska Tier 1 At-list species.
Hickory-nut. Obovaria olivaria. Reported for the Elkhorn and Nemaha basins.
Purple Heel-splitter. Pomatilus alatus. Reported for Platte, Elkhorn and Nemaha basins.
Pink Heel-splitter. Potamilus ohiensis. Reported for Platte, Elkhorn and Nemaha basins.
Pimpleback. Quadula pustulosa. Reported for the Missouri, Platte, Elkhorn and Nemaha basins. Nebraska Tier 1 At-list species.
Maple-leaf Mussel. Quadrula quadrula. Reported for Platte, Elkhorn and Nemaha basins.
Squaw-foot. Strophitus u. undulatus. Reported for Platte, Elkhorn and Nemaha basins.
Liliput Shell. Toxolasma parva. Reported for the Platte, Elkhorn and Nemaha basins.
Pistol-grip. Tritogonia verruscosa. Reported for the Missouri, Elkhorn and Nemaha basins. Nebraska Tier 1 At-list species.
Fawn's Foot. Truncilla donaciformis. Reported for the Elkhorn and Nemaha basins.
Deer Toe. Truncilla truncata. Reported for the Elkhorn and Nemaha basins.
Pond Horn Shell. Uniomerus tetralasmus. Mud-bottom wetlands, Platte, Elkhorn and Nemaha basins.

Appendix 6

Dragonflies and Damselflies of Nebraska's Wetlands

This list of nearly 60 species excludes some rare or local species. All of Nebraska's Odonata are illustrated by Paulson (2009). Distribution statements are based on that reference and U.S.G.S. website: http://www.npwrc.usgs.gov/resource/distr/insects/dfly/ne/toc.htm.

DRAGONFLIES

Aeshnidae - Darners

Canada Darner. Aeshna canadensis. Widespread.
Lance-tipped Darner. Aeshna constricta. Northern Nebraska.
Variable Darner. Aeshna interrupta. Northern Nebraska.
Shadow Darner. Aeshna umbrosa. Widespread.
Common Green Darner. Anax junius. Widely distributed on ponds.
Fawn Darner. Boyeria vinosa. Eastern Nebraska.
Blue-eyed Darner. Rhionaeshna multicolor. Widespread.

Gomphidae - Clubtails

Plains Clubtail. Gomphus externus. Throughout state, especially east.
Pronghorn Clubtail. Gomphus graslinellus. Eastern Nebraska.
Pale Snaketail. Ophiogomphus severus. Northwestern Nebraska.
Common Sanddragon. Progomphus obscurus. Southern Nebraska.
Riverine Clubtail. Stylurus amnicola. Northeastern Nebraska.
Brimstone Clubtail. Stylurus intricatus. Throughout state.

Corduliidae – Emeralds & Basketails

Prince Baskettail. Epitheca princeps. Eastern third of state.
Common Baskettail. Epitheca cynosura. Eastern half of state.

Libellulidae - Skimmers

Halloween Pennant. Celithemis eponina. Widespread.
Eastern Pondhawk. Erythemis simplicicollis. Throughout state.
Dot-tailed Whiteface. Leucorrhinia intacta. Throughout state.
Widow Skimmer. Libellula luctuosa. Throughout state.
Twelve-spotted Skimmer.. Libellula pulchella. Throughout state.
Four-spotted Skimmer. Libellula quadrimaculata. Throughout state.
Blue Dasher. Pachydiplax longipennis. Throughout state.
Wandering Glider. Pantala flavescens. Throughout state.
Spot-winged Glider. Pantala hymenaea. Throughout state.
Eastern Amberwing. Perithemis tenera. Mainly eastern Nebraska.
Common Whitetail. Plathemis lydia. Throughout state.
Variegated Meadowhawk. Sympetrum corruptum. Throughout state.
Saffron-winged Meadowhawk. Sympetrum costiferum. Northern
Cherry-faced Meadowhawk. Sympetrum internum. Widespread.
White-faced Meadowhawk. Sympetrum obtrusum. Widespread.
Band-winged Meadowhawk. Sympetrum semicinctum. Mainly western and Sandhills.
Ruby Meadowhawk. Sympetrum rubicundulum. Widespread.

Yellow-legged Meadowhawk. Sympetrum vicinum. Throughout state.
Black Saddlebags. Tramea lacerata. Widespread.
Red Saddlebags. Tramea onusta. Widespread.

DAMSELFLIES

Lestidae - Spreadwings

Spotted Spreadwing. Lestes congener, Northwestern Nebraska; ponds.
Slender Spreadwing. Lestes rectangularis. Eastern Nebraska; shady ponds.
Lyre-tipped Spreadwing. Lestes unguiculatus. Widespread; small ponds and sloughs.

Coenagrionidae - Bluets & Dancers

Variable Dancer. Argia fumipennis. Widespread; lakes, ponds.
Springwater Dancer. Argia plana. Widespread; slow streams and ponds.
Blue-ringed Dancer. Argia sedula. Southern Nebraska; lakes and gentle streams.
Rainbow Bluet. Enallagma antennatum. Widespread; slow streams and ponds.
Azure Bluet. Enallagma aspersum. Eastern Nebraska; marshy lakes and ponds.
Double-striped Bluet. Enallagma basidens. Southern Nebraska; ponds and lake margins.
Tule Bluet. Enallagma carunculatum. Widespread; ponds and lake margins
Familiar Bluet. Enallagma civile. Widespread; ponds, marshes, lakes
Alkali Bluet. Enallagma clausum. Northwestern Nebraska; alkaline waters.
Northern Bluet. Enallagma annexum. Northern Nebraska; ponds, marshes and lakes.
Skimming Bluet. Enallagma geminatum. Southeastern Nebraska; ponds and lakes.
Hagen's Bluet. Enallagma hageni. Widespread; ponds, marshes and bogs.
Arroyo Bluet. Enallagma praevarum. Western Nebraska; ponds and streams.
Orange Bluet. Enallagma signatum. Central and eastern Nebraska; slow streams and lakes.
Plains Forktail. Ischnura damula. Western Nebraska; ponds.
Citrine Forktail. Ischnura hastata. Southeastern Nebraska.
Western Forktail. Ischnura perparva. Western Nebraska; ponds and slow streams.
Eastern Forktail. Ischnura verticalis. Widespread; ponds and streams.
Sedge Sprite. Nehalennia irene. Northern Nebraska; marshes and fens.

Appendix 7

Common Aquatic Invertebrates of Nebraska's Wetlands

Only a few representative families, genera and species of the many large and technically complex groups of invertebrates are shown on the following list. Several major non-protozoan and little-known invertebrate groups (flatworms, bryozoans, annelids, *etc.*) have been excluded. Species or genera reported by McCarraher (1977) from the Sandhills wetlands are indicated by asterisks. The insect genera and species listed mostly are those having broad distributions and that are likely to occur anywhere in the state. The best regional identification reference is the guide produced by the Kansas Biological Survey (2006).

Phylum Rotatoria (rotifers)

Representative rotifers: Asplanchna, Brachionus plicitilis, Filinia, Hexartha, Keratella, Notholoca squamula, Platyias plyacanthus & Synchaeta pectinatus*

Phylum Mollusca (mollusks)

Class Gastropoda (univalve mollusks)

- Family Lymnaeidae (pond snails): Lymnaea sp.*
- Family Planorbidae (ram's horn snails): Gyraulis, Helisoma, Physa & Promenetus*

Class Pelecypoda (bivalve mollusks)

- Family Unionidae (clams and mussels): See Appendix 6

Phylum Arthropoda (arthropods)

Class Crustacea (crustaceans)

Subclass Branchipoda (branchiopods)

- Order Anostraca (fairy and brine shrimp): Artemia salina (brine shrimp), Branchionecta spp. (fairy shrimp, especially B. campestris, B. lindahli, and B. machini), Chirocephalopsis, Eubranchipus & Streptocephalus spp.*
- Order Conchostraca (clam shrimps): Cyzicus sp.*, Eulimnadia texana & Caenestheriella setosa
- Order Cladocera (cladocerans or water fleas): Alona, Bosmina, Ceriodaphne, Chydorus, Daphnia, Molina, Pleuroxis & Simocephalus spp.*
- Order Copepoda (copepods): Cyclops bicuspidatus, Diaptomus clavipes, c. nevadensis, D. sicilis, D. siciloides & Canthocampus spp.*
- Order Notostraca (tadpole shrimps): Lepidurus couesi*

Subclass Malacostraca (malacostracans)

- Order Amphipoda (amphipods): Gyraulis, Heliosoma, Hyalella, Lymnaea, Physa, Promenetus spp.
- Order Decapoda (crayfish & freshwater shrimps): Cambarus spp.

Subclass Ostracoda (seed shrimps): several genera.

Class Insecta (insects)

Order Coleoptera (beetles)

- Cicindelidae (tiger beetles): Cicindela spp. (including Cicindela nevadica var. lincolniana: Salt Creek tiger beetle—nationally endangered).
- Dytiscidae (predaceous diving beetles): Cybister fimbriolatus, Dytiscus verticalis
- Gyrinidae (whirligig beetles): Dineutus assimilis, D. nigrior
- Hydrophilidae (water scavenger beetles): Hydrophilus tringularis

Order Diptera (two-winged flies)

- Ceratopogonidae (biting midges)
- Chironomidae (midges): Chironominae spp., esp. Chironomus attenuatus

Culicidae (mosquitoes): Aedes, Anopheles, Culiseta, Psorophora
Dolichopodidae (long-legged flies)
Ephydridae (shore flies)
Muscidae (house flies and stable flies)
Sciardidae (fungus and root gnats)
Sciomyzidae (marsh flies)
Simulide (black flies): Simulum vittatum
Tabanidae (deer flies): Chrysops, Tabanis
Tipulidae (crane flies): Erioptera, Nephrotoma, Tipula

Order Ephemeroptera (mayflies)
Baetidae (Small minnow mayflies)
Ephemeridae (burrower mayflies): Hexagenia limbata

Order Hemiptera (true bugs)
Belastomatidae (giant water bugs): Lethocerus griseus, L. americanus, Belostoma flumineum
Corixidae (water boatmen): Sigara alternata
Gerridae (water striders): Gerris remigis, G. conformis
Nepidae (water scorpions): Ranatra fusca
Notonectidae (backswimmers): Notonecta undulata
Veliidae (broad-shouldered water striders): Microvelia americana

Order Odonata (dragonflies and damselflies): See Appendix 7

Order Trichoptera (caddisflies)
Leptocercidae (Long-legged caddisflies)
Limnephilidae (Northern caddisflies)

Appendix 8

Woody Plants of Nebraska's Wetlands

The approximately 60 trees, shrubs and vines listed here are mostly associated with Nebraska's floodplain forests, shorelines and riparian edges. Many of these species were described by Ratzlaff and Barth (2007), Runkel and Roosa (1999), and Stephens (1969). Keys and county-based range maps for all of Nebraska's vascular plant species were provided by Kaul, Sutherland, & Rolfsmeier (2006). Keys to 300 species of midwestern wetland plants are also available on-line (Northern Prairie Wildlife Research Center, 2006). Families, genera and species are listed alphabetically.

Trees

Aceraceae – Maple Family
Box elder. Acer negundo. Entire state; floodplain forests.
Silver maple. Acer saccharinum. Eastern; floodplain forests.
Annonaceae – Pawpaw Family
Pawpaw. Asimina triloba. Southeastern; floodplain forests.
Betulaceae – Birch Family
Mountain (water) birch. Betula occidentalis. Pine Ridge; floodplain forests.
Paper birch. Betula papyrifera. Central Niobrara Valley; floodplain forests.
Hop hornbeam. Ostrya virginiana. Niobrara and Missouri valleys; floodplain forests.
Caesalpiniaceae – Senna Family
Redbud. Cercis canadensis. Lower Missouri Valley; floodplain forests.
Honey locust. Gleditsia triacanthos. Eastern; floodplain forests.
Kentucky coffee-tree. Gymnocladus dioca. Niobrara and Missouri valleys; floodplain forests.
Elaeagnaceae – Oleaster Family
Russian-olive. Elaeagnus angustifolia. Sandy river valleys. Introduced & invasive
Fagaceae – Oak Family
Red oak. Quercus (rubra) borealis. Eastern; floodplain forests.
Scarlet oak. Quercus coccinea. Southeastern; floodplain forests.
Laurel (Shingle) oak. Quercus imbricaria. Southeastern; floodplain forests.
Hippocastanaceae – Buckeye Family
Ohio buckeye. Aesculus glabra. Southeastern; floodplain forests.
Juglandaceae – Walnut Family
Bitternut hickory. Carya cordiformis. Southeastern; floodplain forests.
Bignut hickory. Carya laciniosa. Southeastern; floodplain forests.
Shellbark (Shagbark) hickory. Carya ovata. Southeastern; floodplain forests.
Mockernut hickory. Carya tomentosa. Southeastern; floodplain forests.
Butternut. Juglans cinerea. Southeastern; floodplain forests.
Black walnut. Juglans nigra. Eastern and central, floodplains and uplands.
Moraceae – Mulberry Family
White mulberry, Morus alba. Widespread, floodplain forests; introduced, weedy.
Red mulberry. Morus rubra. Eastern; floodplain forests.
Oleaceae – Ash family
White ash. Fraxinus americana. Lower Missouri Valley; floodplain forests.
Green ash. Fraxinus pennsylvanica. Entire state; floodplain forests.
Plantanaceae – Sycamore Family
Sycamore. Platanus occidentalis. Lower Missouri Valley; floodplain forests.
Rosaceae – Plum Family
Wild black cherry. Prunus serotina. Southern and southeastern; floodplain forests.
Salicaceae – Willow Family
Lance-leaf cottonwood. Populus x acuminata (P. angustifolia x deltoides). Panhandle; floodplain forests, streamsides.
Plains cottonwood. Populus deltoides. Entire state; floodplain forests.
Quaking aspen. Populus tremuloides. Northern; floodplain forests.

Peach-leaved willow. Salix amygdaloides. Widespread; wet soils.
Black willow. Salix nigra. Southeastern; wet floodplain forests.

Tamaricaceae – Tamarisk Family

Salt-cedar. Tamarix chinensis. Western; sandy and gravelly river valleys. Introduced and highly invasive.

Tiliaceae – Basswood Family

Basswood (Linden). Tilia americana. Eastern; floodplain forests.

Ulmaceae – Elm Family

Hackberry. Celtis occidentalis. Entire state; floodplain forests.
American elm. Ulmus americana. Entire state; floodplain forests.
Red (Slippery) elm. Ulmus rubra. Eastern half of state; floodplain forests.
Cork elm. Ulmus thomasii. Northern and eastern; floodplain forests.

Shrubs & Woody Vines

Anacardiaceae – Cashew Family

Poison ivy. Toxicodendron (Rhus) spp. Statewide; moist woody edges. Often vine-like in wooded habitats.

Betulaceae - Birch Family

American hazelnut. Corylus americana. Eastern; floodplain forests.

Caprifoliaceae – Honeysuckle family

Elderberry. Sambucus canadensis. Widespread; moist soils.

Celastraceae – Staff-tree Family

Wahoo. Euonymus atropurpureus. Eastern; streambanks.

Cornaceae – Dogwood Family

Pale (Silky) dogwood. Cornus amomum. Eastern; moist floodplains.
Rough-leaved dogwood. Cornus drummondii. Eastern; marshes, riversides.
Red osier dogwood. Cornus stolonifera. Widespread; marshes, riversides.

Fabaceae – Bean Family

False indigo. Amorpha fruticosa. Statewide; streamsides, most soils.

Grossulariaceae – Currant Family

Black currant. Ribes americana. Widespread; moist soils.
Northern gooseberry. Ribes oxycanthoides. Northwestern; moist soils.

Rosaceae – Rose Family

Juneberry. Amelanchier canadensis. Lower Missouri Valley; floodplains.
Shrubby cinquefoil. Potentilla paradoxa. Widespread; streamsides.
Wild plum. Prunus americana. Entire state; floodplains.
Eastern chokecherry. Prunus virginiana. Entire state; floodplains.

Rubiaceae – Coffee Family

Buttonbush. Cephalanthus occidentalis. Eastern; wet ditches.

Rutaceae – Rue Family

Prickly ash. Zanthoxylum americanum. Eastern; moist woods.
Salicaceae – Willow Family (some species may approach tree-size)
Bebb's (Long-beaked) willow. Salix bebbiana. Panhandle; boggy soils.
Diamond willow. Salix eriocephala. Entire state; wetland soils.
Coyote (Sandbar) willow. Salix exigua. Widespread along riparian edges.
Sandbar willow. Salix interior. Widespread on wetland soils.

Saxfragaceae – Saxifrage Family

American black currant. Ribes americanus. Widespread; moist woods.
Missouri gooseberry. Ribes missouriensis. Eastern; moist woods.

Smilacaceae – Greenbriar Family

Carrion-flower. Smilax lasioneura. Eastern and northern; floodplains.

Staphyleaceae – Bladdernut Family

Bladdernut. Staphylea trifolia. Missouri Valley; moist woods.

Vitaceae – Grape Family

River-bank grape. Vitis riparia. Statewide; often on shorelines.

Appendix 9

Forbs of Nebraska's Wetlands

The following nearly 200 herbaceous plant species are mostly those associated with marhes, wet meadows, shorelines and riparian woods . Many of them are illustrated by Runkel and Roosa (1999) and Muller (2005). Identification keys and range maps may be found in Kaul, Sutherland & Rolfsmeier (2006), whose taxonomy is followed here. Keys to 300 species of Mid-western wetland plants are available on-line through the Northern Prairie Wildlife Research Center (2006). Families, genera and species are listed alphabetically. Species identified as Tier-1 At-risk species are those considered to be at greatest risk of extinction by the Nebraska Natural Legacy Project (Panella, 2010).

Acoraceae – Sweet-flag Family
Sweet-flag. Acorus americanus. Eastern; marshes and fens.
Alismataceae – Water-plantain Family
Water-plantain. Alisma triviale. Widespread; shallow ponds.
Amaranthaceae – Pigweed Family
Common water hemp. Amaranthus rudis. Mostly eastern; weedy.
Anacardiaceae – Cashew Family
Poison ivy. Toxicodendron (Rhus) spp. Statewide; moist woody edges. Often shrubby or vine-like in woodlands.
Apiaceae (= Umbellifereae) – Parsley Family
Poison hemlock. Conium maculatum. Widespread; wet meadows, weedy. Poisonous.
Water hemlock. Cicuta maculata. Widespread; weedy.
Prairie parsley. Polytaenia nuttallii. Eastern third; low, moist prairies.
Water parsnip. Sium suave. Wet soils, marsh edges; Sandhills.
Heartleaf alexander. Zizia aptera. Moist meadows.
Golden alexander. Zizia aurea. Missouri Valley; low prairies, ditch margins.
Apocynaceae (= Asclepidaceae) – Dogbane/Milkweed Family
Hemp (Prairie) dogbane. Apocynum cannabinum. Widespread; weedy. Poisonous.
Swamp milkweed. Asclepias incarnata. Widespread; wet prairies, moist banks.
Showy milkweed. Asclepias speciosa. Mostly western; moist prairies, near water.
Prairie milkweed. Asclepias sullivanti. Eastern; wet meadows.
Common milkweed. Asclepias syriaca. Mostly eastern; banks, floodplains, waste areas.
Araceae – Arum Family
Jack-in-the-pulpit. Arisaema triphyllum. Eastern third; moist, humid woods. Poisonous.
Asteraceae (= Compositae) – Sunflower Family
Western ragweed. Ambrosia psilostachya. Widespread, weedy.
Biennial wormwood. Artemisia biennis. Widespread; damp, sandy soil, streambanks.
Bog aster. Aster borealis. Sandhills fens.
Rayless salt-marsh aster. Aster brachyactis.Wet saline meadows, North Platte & Central Platte valleys.
Willowleaf aster. Aster praealtus. Eastern half; damp or drying sites.
Slender (Saltmarsh) aster. Aster subulatus var. ligulatus. Southeastern; saline wetlands.
Flat-top aster. Aster umbellatus var. pubens. Sandhills fens.
Spanish needles. Bidens bipinnata. Eastern half; damp, disturbed sites, weedy.
Nodding beggarsticks. Bidens cernua. Widespread; wet soils.
Tickseed sunflower. Bidens coronata. Eastern half; damp, sandy sites.
Devils beggarticks. Bidens frondosa. Widespread; moist wooded sites.
Tall beggarsticks. Bidens vulgata. Central and eastern; wet soils.
Musk thistle. Carduus nutans.Widespread, weedy.
Canada thistle. Cirsium arvense, Widespread, weedy.
Flodman's thistle. Cirsium flodmanii. Widespread; moist pastures, weedy.
Bull thistle. Cirsium vulgare. Widespread, weedy.
Horseweed. Conyza canadensis. Widespread, weedy.
Plains coreopsis. Coreopsis tinctoria. Widespread; wet meadows.
Hawk's-beard. Crepis runcinata. Mostly western; open, often damp, meadows.
Spotted Joe Pye weed. Eupatorium maculatum. Widespread; shady marshes.
Boneset. Eupatorium perfoliatum. Widespread; damp, low ground.
Common sneezeweed. Helenium autumnale. Widespread; moist, open sites.

Sawtooth sunflower. Helianthus grosseserratus. Eastern; moist soil.
Jerusalem artichoke. Helianthus tuberosus. Widespread; open or shaded, moist sites.
Marshelder. Iva annua. Widespread; wet saline or alkaline meadows.
Poverty-weed. Iva axillaris. Panhandle and alkaline or saline meadows
Blue lettuce. Lactuca oblongifolia. Widespread; low, moist meadows.
Prickly lettuce. Lactuca serriola. Widespread, weedy.
Prairie coneflower. Ratibida columnifera. Widespread, meadows & psstures.
Annual goldenweed. Rayjacksonia (Happlopappus) annua. Western, sandy & alkaline soils.
Golden-glow. Rudbeckia laciniata. Eastern half; moist places.
False salsify. Scorzonera laciniata. Western, introduced weed.
Cup plant. Silphium perfoliatum. Eastern third; moist, low ground.
Canada goldenrod. Solidago canadensis. Widespread; dry or drying open sites.
Giant goldenrod. Solidago gigantea. Widespread; damp soils.
Dandelion. Taraxacum officinale. Widespread, intoduced weed.
Western ironweed. Vernonia fasciculata. Eastern half; moist prairies.

Balsaminaceae – Touch-me-not Family

Spotted touch-me-not. Impatiens capensis. Widespread; shady, moist woods.

Boraginaceae – Borage Family

Seaside heliotrope. Heliotropium curassavicum. Panhandle; saline flats and marshes.

Brassicaceae – Mustard Family

Toothwort. Cardamine (Dentaria) concatenata. Southeastern; moist woods.
Dame's rocket. Hesperis matronalis. Widespread; damp soils. Introduced weed.
Peppergrass. Lepidium densiflorum. Widespread, weedy.
Water cress. Nasturtium officiale. Widespread; in cold, running water. Introduced.
Bog yellow-cress. Rorippa palustris. Widespread; damp soils, marshes.
Thelypody. Thelypodium curassavicum. Panhandle, in strongly alkaline soils.

Campanulaceae – Bellflower Family

American bellflower. Campanula americana. Eastern streamsides.
Marsh bellflower. Campanula aparinoides. Sandhills; marshes and meadows.
Blue lobelia. Lobelia siphilitica. Widespread; moist soil, woods and meadows.
Palespike lobelia. Lobelia spicata. Widespread; moist soils.

Cannabinaceae – Hemp Family

Hemp. Cannabis sativa. Widespread; moist bottomlands; weedy.

Caryophyllacee – Honeysuckle Family

Salt marsh sand spurrey. Sperglaria marina. Western, alkaline soil, introduced.

Chenopodiaceae – Goosefoot Family

Silver orache. Atriplex argentea. Alkaline marshes of Panhandle and Salt Creek basin.
Saltmarsh spearscale. Atriplex dioca. Alkaline marshes of Panhandle and Salt Creek basin.
Halberd-leaved atriplex. Atriplex prostrata, Alkaline soils, North Platte & Platte valleys. Introduced.
Spearscale. Atriplex subspicata. Eastern saline wetlands.
Pitseed goosefoot. Chenopodium berlandieri. Widespread, weedy.
Kochia. Kochia scoparia.Widespread, weedy.
Saltwort. Salicornia rubra. Salt Creek basin saltflats. State endangered; Tier 1 At-risk species.
Sea blite. Suaeda calceoliformes (= S. depressa). Saline marshes, western Nebraska and Salt Creek basin.

Cleomaceae – Cleome Family

Eastern cleomella. Cleomella angustifolia. Scattered records, river gravel or sandbars.
Rocky Mountain bee plant. Cleome serrulata.Widespread, weedy.

Clusiaceae – Mangosteen Family

Marsh St. John's-wort. Triadenum fraseri. Sandhills fens.

Convolvulaceae – Morning-glory Family

Field bindweed. Convolvulus arvensis. Widespread; moist to dry soils. Noxious weed.

Crassulaceae – Stonecrop Family

Ditch stonecrop. Penthorum sedoides. Mostly eastern; ditches, streambanks.

Curcubitaceae – CucumberFamily

Bur cucumber. Sicyos angulatus. Southeastern; damp river soils, waste sites.

Dryopteraceae – Fern Family

Sensitive fern. Onoclea sensibilis. Sandhills marshes.

Fabaceae – Bean Family

Wild licorice. Glycorrhiza lepidota. Widespread, floodplain medows.
Black medic. Medicago lupulina. Widespread, weedy.
Alfalfa, Medicago sativa. Widespread, weedy.
White sweet clover. Melilotus alba. Widespread, weedy. Introduced.

Yellow sweet clover. Melilotus officinalis. Widespread, weedy. Introduced.
Strawberry clover. Trifolium fragiferum. Alkaline meadows, introduced.

Gentianaceae – Gentian Family

Prairie gentian. Eustoma grandiflorum. Mostly western; moist meadows and prairies.
Closed (bottle) gentian. Gentiana andrewsii. Northern; wet meadows, fens, prairies, woods.

Iridaceae – Iris Family

Yellow flag. Iris pseudacorus. Marshes, shorelines. Introduced.
Blue-eyed grass. Sisyrinchium montanum.

Juncaginaceae – Arrowgrass Family

Arrowgrass. Triglochin maritimum. Western; moist, alkaline sites.

Lamiaceae (= Labiatae) – Mint Family

American bugleweed. Lycopus asper. Widespread, near water.
American water-horehound. Lycopus americanus. Widespread; moist ground.
Motherwort. Leonurus cardiaca. Eastern; along streams.
Field mint. Mentha arvensis. Widespread; moist sites.
Obedience plant. Physostegia virginiana. Eastern; moist soils.
Virginia mountain mint. Pycnanthemum virginianum. Eastern half; moist woods, wetlands.
Marsh scullcap. Scutellaria galericulata. Mostly western; wet sites.
Mad dog (Blue) scullcap. Scutellaria laterifolia. Widespread; marshy soil.
Marsh hedge-nettle. Stachys palustris. Mostly eastern; wet prairies.
American germander. Teucrium canadense. Widespread; streambanks, pastures.

Liliaceae – Lily Family

Wild onion. Allium canadense. Southeast; wet pastures.
Turk's cap (Canada) lily. Lilium canadense. Missouri Valley; moist prairies and woods.
Wood lily. Lilium philadelphia. Peaty mounds on Sandhills fens.
Smooth Solomon's seal. Polygonatum commutatum. Widespread; along streams, moist woodlands.

Lythraceae – Loosestrife Family

Intrermediate toothcup. Ammannia robusta. Widespread; shorelines, drying sites.
Winged loosestrife. Lythrum alatum. Widespread; wetland margins.
Purple loosestrife. Lythrum salicaria. Widespread; moist sites, Introduced weed.

Malvaceae – Mallow Family

Swamp rose-mallow. Hibiscus laevis. Eastern; water edges.
Marsileaceae – Pepperwort Famly
Water-clover. Marsilea vestita. Widespread; roadside ditches.

Menyanthaceae – Bog-bean Family

Bog-bean. Menyanthes trifoliata. Sandhills fens.

Onagraceae – Evening Primrose Family

Colorado butterfly plant. Gaura neomexicana coloradensis. Rare in wet meadows, Kimball County. Tier-1 At-risk species (federally threatened, state endangered).
Velvety gaura. Gaura parviflora. Widespread, weedy.
Water-purslane. Ludwigia palustris. Eastern; streams amd swamps.
Common evening primrose. Oenothera biennis. Widespread; streambanks, open woods.

Ophioglossaceae – Adder's-tongue Fern Family

Adder's tongue. Ophioglossum pusillum. Sandhills fens, Niobrara Valley peat beds.

Orchidaceae – Orchid Family

Small white lady's-slipper. Cypripedium candidum. Eastern and central ; moist meadows and prairies. State threatened; Tier-1 At-risk species.
Large yellow lady-slipper. Cypripedium calceolus. Lower Missouri Valley; moist soils, prairies or woods.
Western prairie fringed orchid. Platanthera praeclara. Moist eastern prairies. Nationally and state threatened; Tier-1 At-risk species.

Papaveraceae – Poppy Family

Bloodroot. Sanguinaria canadensis. Missouri Valley; moist woods.

Phytolcacceae – Pokeweed Family

Common pokeweed. Phytolacca americana. Southeastern; moist woods.

Plantaginaceae – Plantain Family

Slender plantain. Plantago elongata. Alkaline flats; Panhandle and Lancaster County.
Alkali plantain. Plantago eriopoda. Western, alkaline & saline marshes.

Polygonaceae – Buckwheat Family

Common knotweed. Polygonum arenostrum. Widespread; disturbed sites. Introduced.
Pink smartweed. Polygonum bicorne. Mostly eastern; wet sites.
Swamp smartweed. Polygonum coccineum. Widespread; wet sites. Weedy.
Mild water peper. Polygonum hydropiperoides. Widespread; muddy or sandy shorelines.
Pale (Nodding) smartweed. Polygonum lapathifolium. Widespread; damp soils.
Pennsylvania smartweed. Polygonum pennsylvanicum. Widespread; moist soils. Weedy.
Water (Dotted) smartweed. Polygonum puctatum. Widespread; shorelines and ditches.
Bushy knotweed. Polygonum ramosissimum. Widespread; damp, brackish soils.

Great water dock. Rumex britannica. Sandhills fens and marshes.
Curly dock. Rumex crispus. Widespread; wetland margins. Introduced.
Golden dock Rumex fueginus. Widespread, sandy shorelines.

Portulacaceae – Purslane Family

Virginia spring beauty. Claytonia virginica. Lower Missouri Valley; moist woods.

Primulaceae – Primrose Family

Shooting star. Dodecathon pulchellum. Scattered records; moist woods and prairies.
Sea-milkwort. Glaux maritima. Scattered records, in alkaline meadows.
Fringed loosetrife. Lysimachia ciliata. Widespread; moist woods and wet sites.
Moneywort. Lysimachia nummularia. Eastern; moist sites. Introduced.
Tufted loosestrife. Lysimachia thyrsiflora. Widespread; moist to wet sites.

Ranunculaceae – Buttercup Family

Meadow anemone. Anemone canadensis. Mostly eastern; wet prairies, wet woods.
Wild columbine. Aquilegia canadensis. Northern and eastern; moist woods.
Marsh marigold. Caltha palustris. Northern; marshes, Sandhills fens.
Early wood (smallflower) buttercup. Ranunculus abortivus. Widespread; moist woods.
Shore buttercup. (Seaside crow's-foot). Ranunculus cymbalaria. Widespread; marshes and meadows.
Threadleaf buttercup. Ranunculus flabellaris. Scattered records; moist and wet sites.
Longbeak white crow's-foot. Ranunculus longirostris. Marshes and ponds.
Macoun's buttercup. Ranunculus macounii. Western half; streambanks, wet meadows.
Bristly crow's-foot. Ranunculus pensylvanicus. Northern; marshy soils.
Purple meadow rue. Thalictrum dasycarpum. Widespread; moist habitats.

Rosaceae – Rose Familly

Silverweed. Potentilla anserina. Pamhandle and eastern Nebraska; rare in sandy, often saline, shorelines.

Scrophulariaceae – Figwort Family

Slender gerardia. Agalinis tenuifolia. Widespread; moist woods and prairies.
Round-leaf monkey-flower. Mimulus glabratus. Widespread; spring seeps.
Allegeny monkey-flower. Mimulus ringens. Eastern; wet soils.
Meadow lousewort. Pedicularis crenulata. Northwestern Panhandle; alkaline and sandy wet meadows. Tier 1 At-risk species.
Swamp lousewort. Pedicularis lanceolata. Sandhills fens.

Thelypteridaceae – Marsh Fern Family

Marsh fern. Thelypteris palustris. Sandhills marshes and fens.

Urticaceae – Nettle Family

False nettle. Boehmeria cylindrica. Widespread; sandy marshes.
Wood nettle. Laportea canadensis. Missouri Valley; moist woods.
Pennsylvania pellitory. Parietaria pensylvanica. Widespread; shaded woods.
Stinging nettle. Urtica dioica. Widespread; moist woods, streambanks.

Verbenaceae – Vervain Family

Wedgeleaf fogfruit. Phyla(Lippia) cuneifolia. Southwestern; playas and rainbasins.
Northern fogfruit. Phyla(Lippia) lanceolata. Eastern and southern; prairies, ditches, disturbed areas.
Blue vervain. Verbena hastata. Widespread; moist meadows, woods, seepage areas.
White vervain. Verbena urticifolia. Widspread; moist soils.

Violaceae – Violet Family

Downy blue violet. Viola sororia. Northern and eastern; woods, streamsides.

Appendix 10

Grasses, Sedges and Rushes of Nebraska Wetlands

This list includes about 80 of Nebraska's more widespread grasses, sedges and rushes found in moist soils, including some dryland species that are sometimes reported from wetlands. Arranged alphabetically by genera and species. Descriptions and range maps were provided by Kaul, Sutherland, & Rolfsmeier (2006), whose taxonomy is followed here. All of Nebraska's grasses were illustrated and described by Hitchcock (1937). Many of the sedges listed here were illustrated and described by Ratzlaff and Barth (2007), and by Runkel and Roosa (1999).

Cyperaceae – Sedge Family

Alkali (Nevada) bulrush. Amphiscirpus (Scirpus) nevadensis. Panhandle; highly alkaline shores and flats.
River bulrush. Bulboschoenus fluviatilis. Widespread; marshy shorelines.
Saltmarsh bulrush. Bulboschoenus maritimus. Saline marshes; mostly western.
Water sedge. Carex aquatilis. Sandhills fens.
Shortbeak sedge. Carex brevior. Widespread; wet meadows, tolerant of saline soils.
Bearded sedge. Carex comosa. Eastern and central; pond and stream margins; semi-aquatic.
Emory's sedge. Carex emoryi. Widespread; streambanks and ditches.
Heavy sedge. Carex gravida. Widespread; moist meadows.
Shoreline sedge. Carex hyalinolepis. Eastern; marshes and floodplains.
Bottlebrush sedge. Carex hystericina. Widespread; marshes, wet meadows; semi-aquatic.
Lacustrine sedge. Carex lacustris. Water edges; widespread.
Smoothcone sedge. Carex laeviconica. Eastern; various wet habitats.
Woolly sedge. Carex languinosa. Widespread; low prairies; semi-aquatic.
Mud sedge. Carex limosa. Sandhills fens
Nebraska sedge. Carex nebraskensis. Mostly western; swamps, wet meadows.
Prairie sedge. Carex prairea. Sandhills fens, seeps and wet meadows.
Clustered field sedge. Carex praegracilis. Widespread, common in alkaline soils.
Sawbeak sedge. Carex stipata. Widespread; marshes, streams; emergent.
Fox sedge. Carex vulpinoidea. Widespread; pond edges; semi-aquatic.
Umbrella flatsedge Cyperus diandrus. Widespread; sandy shorelines.
Red-rooted sedge. Cyperus erythrorhiza. Eastern; muddy shores.
Yellow nutsedge. Cyperus esculentus. Eastern; muddy shores.
Fragrant sedge. Cyperus odoratus. Widespread; muddy soils.
Needle spike-rush. Eleocharis acicularis. Widespread; muddy or sandy shorelines.
Redstem spike-rush. Eleocharis erythropoda. Widespread; marshes and streamsides.
Common spike-rush. Eleocharis palustris. Widespread; shorelines and ditches.
Wolf's spike-rush. Eleocharis wolfi. Wet meadows and shorelines in eastern and northern Sandhills. Nebraska Tier-1 At-risk species.
Cotton-grass. Eriophorum angustifolium. Sandhills fens.
Slender cotton-grass. Eriophorum gracile. Sandhills fens.
Dark-green bulrush. Scirpus atrovirens. Eastern; marshy shorelines.
Pale bulrush. Scirpus pallidus. Widespread; marshy shorelines.
Pendant bulrush. Scirpus pendulus. Eastern; marshy shorelines.
Hardstem bulrush. Schoenoplectus (Scirpus) acutus. Widespread; marshy shorelines.
Hall's bulrush. Schoenoplectus (Scirpus) halli. Wetlands of northeastern Sandhills. Nebraska Tier-1 At-risk species.
Common threesquare. Schoenoplectus (Scirpus) pungens. Widespread; shorelines and aquatic.
Softstem bulrush. Schoenoplectus (Scirpus) tabernaemontani. Widespread; shorelines and aquatic.

Juncaceae – Rush Family
Rush. Juncus articulatus. Local, streamsides and fens.
Baltic rush. Juncus arcticus(= balticus). Widespread; wet meadows.
Toad rush. Juncus bufonius. Widespread; brackish marshes.
Dudley rush. Juncus dudleyi. Widespread; wet meadows.
Interior rush. Juncus interior. Widespread; wet meadows
Torrey's rush. Juncus torreyi. Widespread; wet meadows
Juncaginaceae – Arrowgrass Family
Arrowgrass. Triglochin maritima. Western and central, saline meadows.
Poaceae – Grass Family
Redtop. Agrostis stolonifera. Low, moist ground; introduced.
American sloughgrass. Beckmannia syzigachne. Northwestern; wetlands.
Blue grama. Bouteloua gracilis. Widespread, prairie and waste ground.
Smooth brome. Bromus inermis. Widespread; introduced weed.
Japanese brome. Bromus japonica. Widespread; introduced weed.
Downy brome, Bromus tectorum Widespread; introduced weed.
Bluejoint reedgrass. Calamogrostis canadensis. Widespread; marshes, sloughs and ravine bottoms.
Orchardgrass. Dactylis glomerata. Widespread; introduced weed.
Inland saltgrass. Distichlis spicata. Widespread; saline soils. Weedy, tolerates very high alkalinity levels.
Barnyardgrass. Echinochloa crus-galli. Widespread; moist soils. Introduced weed.
Goosegrass. Eleusine indica. Southeastern; introduced weed.
Canada wildrye. Elymus canadensis. Widespread; moist soils.
Tall wheatgrass. Elymus (Agropyron) elongatus. Weedy, introduced.
Western wheatgrass. Elymus (Agropyron) smithi. Weedy, introduced.
Slender wheatgrass. Elymus (Agropyron) trachycaulus. Weedy, introduced.
Tall manna grass. Glyceria grandis. Northern; shorelines.
Fowl manna grass. Glyceria striata. Widespread; moist soils.
Foxtail barley. Hordeum jubatum. Widespread; weedy; often on saline soils..
Little barley. Hordeum pusillum. Widespread; weedy.
Alkali muhly. Muhlenbergia asperifolia. Widespread; moist soils.
Marsh muhly. Muhlenbergia racemosa. Widespread; weedy.
Witchgrass. Panicum capillare. Widespread; weedy.
Switchgrass. Panicum virgatum. Widespread; moist prairies.
Reed canary grass. Phalaris arundinacea. Widespread; wet soils. Invasive species.
Common reed. Phragmites australis. Widespread; wet soils. Several genotypes are present, of which some are more invasive than the native type. Also known as P. communis.
Annual bluegrass. Poa annua. Eastern; introduced weed.
Plains bluegrass. Poa arida. Widespread; often on alkaline or sandy soils.
Giant foxtail. Setaria faberi. Eastern half. Introduced weed.
Yellow foxtail. Setaria glauca. Widespread. Introduced weed.
Bristly foxtail. Setaria verticillata. Widespread. Introduced weed.
Green foxtail. Setaria viridis. Widespread. Introduced weed.
Johnsongrass. Sorghum halepense. Southern and southeastern; moist soils, weedy.
Alkali cordgrass. Spartina gracilis. Western, in alkaline wetlands.
Prairie cordgrass. Spartina pectinata. Widespread; moist, sometime saline, soils.
Prairie wedgegrass, Sphenopholis obtusata. Widespread, wet soils.
Alkali sacaton. Sporobolus airoides. Western and southeastern, saline or alkaline soils.
Wild-rice. Zizania palustris. Eastern and central; freshwater marshes.

Appendix 11

Aquatic Vascular Plants of Nebraska's Wetlands

Novacek (1989) provided a list of more than 100 vascular plants reported from the Nebraska Sandhills that are associated with wetland habitats, and Kaul (1989) listed 34 Sandhills genera and species associated with wetland habitats. Wetland plants of the Great Plains were described by Muenschner (1944), Lindstrom (1968), Larson (1993) and Runkel & Roosa (1999).

Diatoms and other algae are not included in the following list of about 60 aquatic plants. McCarraher (1977) provided a list of 71 genera of algae from Sandhills lakes, and Gibson (1976) surveyed the diatoms of Sandhills lakes. See Daily (1944), Daily & Keiner (1956) and Keiner (1948) for surveys of Nebraska's stoneworts (Characeae).

Shoreline and Wet Meadow Species

(Some of the species listed in Appendix 9 as terrestrial forbs have also been included here.)

Calamus (Sweet flag). Acorus calamus Southeastern, probably introduced.
Water plantain. Alisma gramineum. North-central.
Water plantain. Alisma triviale. Widespread
Buttonbush. Cephalanthus occidentalis. Local, lower Missouri Valley.
Spike-rush. Eleocharis spp. Widespread. especially E. acicularis (hair-grass spike-rush), E. erythropoda (redstem spike-rush), and E. palustris (spike-rush).
Burhead. Echinodorus rostratus. Missouri Valley.
Mud plantain. Heteranthera limosa. Southern half of state.
Rose mallow. Hibiscus militaris. Missouri Valley.
Wild iris. Iris spp. Several species, especially I. virginica (southern blue flag), and I, pseudacorus (yellow flag, introduced).
Purple loosestrife. Lythrum salicaria. Introduced; invasive and noxious species.
Common reed. Phragmites australis. Several non-native genotypes are present, some of which are more invasive than the native type. Also known as P. communis.
Water pepper. Polygonum hydropiper. Eastern half of state.
Mild water pepper. Polygonum hydropiperoides. Southern half of state.
Threadleaf buttercup. Ranunculus flabellaris. Scattered records.
Water parsnip. Sium suave. Widespread.

Emergent Species

Water parsnip. Berula graveolens. Widespread, especially in springs and cool streams.
Brookgrasss. Catabrosa aquatica. Western Sandhills.
Horsetails. Equisetum spp. Widespread, especially E. laevigatum (smooth horsetail) and E. arvense (field horsetail).
Cotton-grass. Eriophorum spp. Local in Sandhills fens.
Hedge hyssop. Gratiola neglecta. Eastern.
Rush. Juncus spp. See grasses and sedges,
Roundleaf monkey-flower. Mimulus glabratus. Widespread.
Water-cress, Nasturtium officiale. Widespread.
Spatterdock. Nuphar luteum. Widespread.
Water cress. Rorippa spp. Widespread.
Short-beak arrowhead. Sagittaria brevirosta. Eastern and southeastern.
Thick-stalk arrowhead. Sagittaria calycina. Eastern and southeastern.
Arum-leaf arrowhead. Sagittaria cuneata. Central and western.
Grass-leaf arrowhead. Sagittaria graminea. Central.
Stiff arrowhead. Sagittaria rigida. North-central.
Common arrowhead. Sagittaria latifolia. Widespread, shallow water.
Giant bur-weed. Sparganium eurycarpum. Widespread, shallow water.

Bulrushes. Bulboschoenus, Scirpus and Schoenoplectus spp. See Appendix 10.
Narrow-leaved cattail. Typha angustifolia. Widespread, especially in alkaline and brackish waters; invasive species.
Common cattail. Typha latifolia. Widespread, shoreline and shallow water.
Brooklime speedwell. Veronica americana. Widespread.
Water speedwell. Veronica anagallis-aquatica. Widespread.

Floating-leaf Species

Water (Mosquito) fern. Azolla mexicana. Erratically distributed, warm-water ponds.
Duckweeds. Lemna spp. Widespread, especially. L. minor (lesser duckweed) and L. trisulca (star duckweed).
Water clover. Marsilea vestita. Widespread, standing waters.
American lotus. Nelumbo lutea. Eastern, shallow water.
Yellow water lily. Nuphar luteum. Local in eastern and central, especially the Sandhills.
American (Fragrant) water lily. Nymphaea odorata. Local in eastern and central, especially the Sandhills.
Variable pondweed. Potamogeton gramineus. Sandhills ponds and streams.
Floating-leaf pondweed. Potamogeton natans. Sandhills and North Plate valley.
Floating-leaf pondweed. Potamogeton nodosus. Widespread, except in Panhandle.
Greater duckweed (Duck's meat). Spirodela polyrhiza. Widespread.
Greater bladderwort. Utricularia macrorhiza. Widespread, especially in Sandhills marshes.
Watermeal. Wolffia spp. Widespread, especially W. columbiana (Columbian watermeal).

Submerged-leaf Species

Starworts. Callitriche spp. Local.
Coontail. Ceratophyllum demersum. Widespread.
Elodea. Elodea canadensis. Widespread.
Water stargrass. Heteranthera dubia. Eastern.
Water purslane. Ludwigia palustris. Eastern.
Water milfoil. Myriophyllum heterophyllum. Widespread.
Eurasian water milfoil. Myriophyllum spicatum. Introduced invasive species.
Naiads. Najas spp. Widespread, including N. flexilis, N. marina & N. guadalupensis
Leafy pondweed. Potamogeton foliosus. Widespread.
Sago pondweed. Potamogeton pectinatus. Abundant, saline or alkaline waters; tolerates very high alkalinity levels.
Small pondweed. Potamogeton pusillus. Common in alkaline or saline waters.
Clasping-leaf pondweed. Potamogeton richardsonii. Sandhills and Panhandle, in neutral to alkaline waters.
Flatstem pondweed. Potamogeton zosteriformis. Lakes and ponds, sandhills and lower Platte valley.
White water crowfoot. Ranunculus longirostris. Widespread.
Wigeon-grass. Ruppia maritima & R. occidentalis. Local in alkaline wetlands, central Platte valley and western Sandhills.
Horned pondweed. Zannichellia palustris. Widespread, ponds and streams.

GLOSSARY

Algae (adj., algal). A group of often microscopic-sized plants common in freshwater wetlands, including epiphyton (on the surface of submerged plants), epipelon (in or on sediments), phytoplankton (suspended in open water) and metaphyton (unattached algae loosely associated with the substrate). Attached algae are part of a broad assemblage of organisms that occur in close association with aquatic plants (periphyton).

Alkalinity. The capacity of the substances dissolved in a fluid to neutralize acid. Alkaline fluids are those with pH levels above 7.0. If excessive levels of cations are present, wetlands may be unable to support most organisms, and are described as hypertrophic. See also halophytes, hypertrophic.

Alluvium (adj., alluvial). Materials transported and deposited by moving water, such as alluvial soils. Alluvial plains are commonly called floodplains. See also lacustrian,palustrine.

Amphipoda. An order of crustaceans (amphipods) whose members are common in freshwater wetlands. See also Crustacea.

Anostraca. An order of branchiopod crustaceans (anostracans) that includes fairy shrimp and brine shrimp and whose members are common in freshwater wetlands. See also Branchiopoda, Crustacea.

Annual. A plant that completes its life cycle, from seed to seed-bearing plant, within a single year, and then dies. See also biennial and perennial.

Aquifer. A geological substrate of saturated sands, gravels, silts, etc., and able to transmit water in significant quantities under hydraulic gradients. Artesian aquifers are those in which pressurized water flows to the surface without pumping. Water tends to move laterally through an aquifer, rather than downward. When several aquifers are treated as a single geographic unit the term "groundwater reservoir" is often used. See also groundwater, Ogallala aquifer, water table.

Arthropoda. A major group of invertebrates (arthropods) having external skeletons and jointed appendages; insects and crustaceans are the most common arthropods in wetland habitats. See also Crustacea.

Association. A specific type of biotic community having a high degree of floristic unifomity and occurring in similar environments. Associations are usually named for one or more common plant species or genera that consistently occur as long-term dominants within that community. See also climax community, community, dominant.

Baccilariophyceae. The botanical classification for the group of algae known as diatoms. See also diatom.

Borrow Pit. A wetland produced by digging a hole in the soil and letting it fill with water, by precipitation run-off or through seepage from the local water table.

Benthos. The bottom-dwelling organisms of an aquatic ecosystem. This substrate habitat is called the benthic zone. See also limnetic.

Biennial. A plant that completes its life cycle, from seed to mature plant and seed production, in two years. In its first year the plant often produces only a simple rosette of leaves. See also annual and perennial.

Biota. The combined flora and fauna of a region or area.

Bog. A wetland characterized by anerobic conditions, peat accumulation and poor plant nutrient availability, owing to low rates of organic matter breakdown, A highly acidic environment and a very limited plant diversity are typical. See also fen, marsh.

Borrow-pit (or dug-out) wetland. An excavated wetland in which the soil substrate has been removed, often for use somewhere else.

Brackish. See salinity.

Braided stream. A meandering river or brook having several shallow and intersecting channels. See also brook, river.

Branchiopoda. A subclass of crustaceans (branchiopods) whose members are common in both freshwater and alkaline wetlands, and include the orders Anostraca, Cladocera, Conchostraca and Notostraca. Because of the leaf-like respiratory structures on their many swimming appendages, these crustaceans also often known as phyllopods. See also Anostraca,Cladocera, Conchostraca, Notostraca.

Brook. A small stream, typically less than three meters (about ten feet) wide. Terms such as "creek" and "rivulet" are synonyms. See also creek, river, stream.

Cenozoic Era. The geologic era encompassing the past 65 million years, following the Mesozoic Era. This interval is often divided into (older) Tertiary and (more recent) Quaternary periods.

Centimeter. A metric measurement equal 0.01 meter or 0.39 inch.

Chadron Arch. A geologic uplift in the western Sandhills that extends from Sheridan and Hooker County, forming an east-west divide in groundwater flow, and causing a closed basin to the west, where many alkaline wetlands are located.

Chlorophyceae. The botanical classification for a photosynthetically important group of green algae.

Chrysophyta. A group of plant known as golden algae. Those algae containing silica skeletons are known as diatoms. See also diatom.

Chute. A channel cut-off that isolates a bend in a river, allowing the isolated section to become increasingly wetland-like.

Cladocera. An order of branchiopod crustaceans (cladocerans) whose members are common in freshwater wetlands, and include water fleas. See also Branchiopoda, Crustacea.

Class. A taxonomic category below that of a phylum, and above that of a subclass or order.

Climate. The long-term weather conditions of an area, including variations in temperature, precipitation, humidity and wind.

Closed basin. An area or region of internal drainage. See also endoreic, perched lake.

Community. In ecology, an interacting group of plants, animals and microorganisms situated in a specific location, tending to recur in different areas but similar habitats, and usually responding similarly to their biotic and physical environments. See also ecosystem, habitat.

Conchostraca. An order of branchiopod crustaceans (conchostracans) that are common in freshwater wetlands and whose members include clam shrimps. See also Branchiopoda, Crustacea.

Copepoda. An order of crustaceans (copepods) whose members are common in freshwater wetlands, and are notable for having a single median eye and no dorsal carapace. See also Crustacea.

Creek. A non-technical name for a small stream. See also brook, river.

CRP. Acronym for the Conservation Reserve Program, a federally funded program that was initiated by the 1985 Farm Bill (Food Security Act), and provides incentives to replace highly erodable agricultural lands with vegetation favoring wildlife, soil and water conservation.

Crustacea. A class of mostly aquatic arthropods (crustaceans) having often calcareous external skeletons, and whose members are common in freshwater wetlands.

Cyanobacteria. The taxonomic name for a group of blue-green algae that are common in freshwater wetlands.

Decapoda. An order of crustaceans (decapods) that are common in freshwater wetlands and includes crayfish & shrimp. See also Crustacea.

Diatoms. A group of golden algae (Chrysophyta) that contain silica skeletons and are usually abundant in both freshwater and marine ecosystems. See also algae, Chrysophyta.

Dicot. Refers to a group of vascular plants (dicotyledons) that are characterized by having broad, web-veined leaves, two embryonic leave within the seed, and flower parts usually consisting of fours, fives or their multiples. See also monocot.

Dominant. In ecology, descriptive of plant taxa that exert the strongest ecological effects (control of energy flow) within a community. See also community, keystone.

Drift. Glacially transported and deposited materials, either unsorted by size (till), or size-sorted (stratified drift). See also moraine, till.

Dystrophic. Refers to bog-like wetlands that are acidic and rich in suspended organic colloids, but very low in important plant nutrients such as nitrates. See also bog, eutrophic, minerotrophic, mire, moor, oligotrophic.

Ecoregions. Regions having similar climates, geomorphology, and potential natural vegetation, containing clusters of interacting landscapes and often diverse ecosystems. See also association, community.

Ecosystem. An interacting group of plants, animals, microorganisms and their physical environment, of no specific size. See also community, habitat.

Ecotone. An ecologic transition zone that physically connects two quite different biotic communities, such as shoreline vegetation. See also succession.

Eolian. Transported by wind. Eolian lakes are those formed in depressions caused by wind action.

Epipelon, See algae

Ephemeral pond. A temporary seasonal wetland, often present only in spring following rain or snowmelt. Also called vernal ponds.

Endemic. Descriptive of taxa that are both native to and limited to a specific habitat or region. See also indigenous.

Endoreic. Describes water bodies or water basins of internal drainage, sometimes called closed basins. See also exoreic, perched lake.

Environment. The natural surroundings of an organism or community of organisms. See also ecosystem, habitat.

Eolian. Wind-transported soil particles, such as silt. See also loess.

Epiphyton. A group of plankton ecologically associated with aquatic plants. See algae.

Eutrophic. Refers to waters that are well provided with mineral nutrients and are able to exhibit high biological productivity. Eutrophication is the process by which lakes and other wetlands gradually accumulate nutrients. See also oligotrophic.

Evolution. Any gradual change. Biological or organic evolution results from changing gene frequencies in successive generations associated with biological adaptations, typically through natural selection.

Exoreic. Describes water bodies or water basins with balanced movements water in and out. See also endoreic.

Extinct. A taxon (usually a species or subspecies) that no longer exists anywhere. See also extirpated.

Extirpated. A taxon that has been eliminated from some part of its range, but still exists elsewhere. See also extinct.

Fairy shrimp. Members (Branchinecta and other genera) of a group (Phyllopoda, Anostraca) of aquatic crustaceans having 11 pairs of leaf-shaped legs, stalked eyes and no carapace. They are frequently found in temporary

and variably mineralized ponds. Related species called brine shrimp (Artemia) are notably tolerant of waters having very high alkalinity levels.

Family. A taxonomic category below that of an order, and above that of a genus.

Fen. A wetland characterized by having a bog-like substrate of organic matter (peat or marl) but, unlike bogs, having favorable plant nutrition levels (especially calcium availability) and much greater biological productivity, owing to an external source of nutrient-rich water. Fens are largely associated with once-glaciated areas, and are rare in Nebraska. See also bog, marsh, mire, peat.

Floodplain. An area adjoining wetlands that is subjected to periodic flooding. Floodplains are sometimes defined as areas experiencing probable flooding within a specific time period (e.g., 100-year floodplains).

Fluvial. Refers to flowing water.

Fluvial geomorphology. The science of how a stream shapes the land over which it flows.

Forbs. Herbaceous plants that are not grasses, rushes or sedges, thus including other narrow-leaved monocots (such as lilies) and broad-leaved dicots. See also dicot, grass, monocot, rush, sedge.

Forests. Wooded communities in which the height of the trees is usually greater than the distances between them, so that the overhead canopy is continuous. See also riparian, savannas, woodlands.

Gallery forests. Narrow riverine woodlands that follow waterways out into non-forested habitats.

Gastropoda. A class of single-shell (univalve) mollusks (gastropods) including snails, typically common in freshwater wetlands.

Genus (adj., generic, pl., genera). A Latin or Latinized name that is applied to one or more closely related species or plants or animals, implying a generalized (generic) relationship among them. The generic name is the first (always capitalized and italicized) component of a species' two-parted "binomial" or scientific name. See also species.

Grass. Herbaceous plants having a round, usually hollow, stem, parallel-veined leaves with a stem-enclosing sheath, and tiny flowers and seeds borne on small spikes. See also rush, sedge.

Great Plains. The non-mountainous region of interior North America lying east of the Rocky Mountains and west of the Central Lowlands of the Mississippi and lower Missouri drainages.

Groundwater. Subsurface water located within the limits of the water table. See also aquifer, water table.

Groundwater lake. A lake that is fed by a local flow system and is in direct connection with the groundwater reservoir. See also perched lake.

Groundwater reservoir. A synonym for a group of aquifers that are considered a single geographic unit. See also aquifer.

Guild. A group of species that exploits the same class of environmental characteristics (such as their preferred foods or foraging adaptations) in a similar way, whether or not they are closely related. See also niche.

Habitat. The general ecological (biotic and physical) environment which a species survives. Thus, its natural "address," as opposed to its ecological profession (niche), or its presence in any specific location (biotic community). See also community, ecosystem, environment, and niche.

Halophytes. Plants adapted to live under conditions of high salinity or alkalinity. See also alkalinity, salinity.

Hectare (abbreviated ha.). A metrically defined area (10,000 square meters), equal to 2.47 acres. A square mile contains 640 acres or 259 hectares.

Herb. Any herbaceous plant with no permanent above-ground woody parts, including grasses, sedges, rushes and forbs. See also forb, herbaceous.

Herbaceous. Non-woody vegetation, typically dying back to ground level after the growing season in temperate regions.

Herbaceous community. Plant communities dominated by herbaceous plants and having a canopy cover of more than 25 percent. Those having a canopy cover of less than 25 percent are termed "sparsely vegetated communities."

High Plains aquifer. See aquifer, groundwater reservoir, Ogallala aquifer.

Holocene Epoch. The roughly 11,000-year interval extending from the end of the last(Wisconsinian) glaciation to the present time. See also Pleistocene Epoch.

Hydric soils. Soils developed under inundated or saturated conditions. The presence of hydric soils, water-adapted plants (hydrophytes) and periodic inundation or saturation of the substrate are the primary hallmarks of wetlands. See also hydrophytes.

Hydrology. The study of water movements on, over and through landscapes. The influences on hydrology on specific wetlands include such important biological potentials as nutrient availability, seasonal water cycles, sediment properties, pH, and overall biotic productivity and diversity.

Hydroperiod. The seasonal pattern of water levels and abundance in a wetland.

Hydrophytes. Plants adapted to living in water or water-saturated soils. See also hydric soils.

Hypersaline wetlands. Wetlands that are saltier than sea water.

Hypertrophic. Descriptive of wetlands high in total phosphorus. Hypertrophic wetlands often are also rather shallow, with large temporal variations in nutrient and oxygen concentrations, small nitrogen to phosphorus ratios, and large fluctuations in algal biomass.

Indicator species. A species whose presence in a community provides evidence of the community's ecological type or general category. See also keystone species.

Indigenous. Descriptive of taxa that are native to, but not necessarily limited to, a particular area or region. See also endemic.

Invasive. Refers to organisms that tend to invade and expand their ranges into communities or habitats they had not previously occupied.

Invertebrates. Animals that lack vertebral columns (backbones) but often have supporting exoskeletons, such as arthropods.

Isohyet. A line on a map connecting points of equal precipitation.

Keystone species. A species whose presence in a community has a significant effect on its ecological structure. See also dominant, indicator species.

Kilogram (kg). A metric measure equal of 1,000 grams, or 2.2047 pounds.

Kilometer (km). A metric distance of 1,000 meters, or 0.6214 mile.

Lacustrian. Refers to lakes and their biota or substrates (lacustrian wetlands), typically being both larger and deeper than marshes (palustrine wetlands). See also lake, marsh, palustrine, riparian,

Lagoon. A popular name often applied locally to playa wetlands in southern Nebraska. See also pothole, slough.

Lake. A "lacustrine" wetland that is typically large enough so that at least part of the shoreline lacks emergent plants owing to wave action, and deep enough that lacks continuous substrate vegetation. Shallower parts of the lake that often have emergent vegetation are called the littoral zone, and those parts deeper than about two meters (6.6 feet) and lacking emergent vegetation are called the limnetic zone. See also lacustrian, limnetic, littoral, marsh, palustrine.

Landscape. A relatively large area within an region in which local vegetative communities or sub-populations occur repetitively. See also ecoregion.

Legumes. Members of the bean family Fabiaceae, many of which harbor nitrogen-converting ("nitrogen-fixing") bacteria in their roots that transform gaseous nitrogen into a molecular form usable by plants.

Lentic. Refers to standing-water habitats. See also lotic.

Life form. A term broadly descriptive of plant growth categories, such as coniferous or deciduous trees, broad-leaved shrubs, perennial grasses, annual forbs, etc.

Limnetic zone. Refers to the zone of a lake that is shallow enough to support submerged vegetation, located between the near-shoreline zone of emergent vegetation (its littoral zone) and its deeper, unvegetated substrate (its benthic zone). See also benthos, littoral zone.

Limnology. The scientific study of lakes, ponds and streams.

Littoral zone. Refers to a lake's shoreline and near-shore perimeter(out to about two meters deep, or to the maximum depth of emergent vegetation). See also benthos, limnetic zone.

Loam. Describes soils containing a mixture of particle sizes, including sand, silt and clay.

Loess (adj. loessal). Colloidal-sized materials (larger than clay, but smaller than sand) that have been transported and deposited by wind as silt. The word is of German origin, meaning "loose" (loess soils are easily eroded), and is pronounced "luss." See also aeolian, silt.

Lotic. Refers to moving-water habitats. See also lentic.

Macroinvertebrates. Invertebrates large enough to be easily seen without magnification.

Macrophytes. Plants larger than those of microscopic size.

Marsh. A "palustrine" wetland in which the soil is saturated for long periods of time, if not permanently, but in which peat does not accumulate. Marshes typically have a continuous littoral (shoreline) zone of emergent vegetation, and are often sufficiently shallow as to have their substrates entirely vegetated by aquatic plants. See also bog, fen, meadow, mire, palustrine, swamp.

Meadow. A general term for a herbaceous community typically rich in grasses and forbs. Freshwater wet meadows are sedge-, rush-, and grass-dominated communities that are sub-irrigated, and often botanically resemble tallgrass prairie. Increasingly alkaline and saline wet meadows have less botanical diversity, and with extreme salt concentrations their plants may be limited to a few halophytic species. See also halophyte, herbaceous, prairie.

Mesic. A habitat with a moderate level of soil moisture (or other general environmental conditions, such as temperature extremes) between extremes of xeric (dry) and wet (hydric).

Metaphyton. See algae.

Meter. A metric measurement equal to 1.094 yards.

Microinvertebrates. Invertebrates too small to be seen without magnification.

Minerotophic. Descriptive of natural communities whose waters come mostly from streams or springs, and tend to be rich in mineral nutrients. The are thus usually base-rich, or variably alkaline as to pH. Those communities whose water comes mostly from precipitation are termed ombrotrophic. They are generally poor in nutrients and tend to be more acidic. Highly acidic communities such as bogs are often termed dystrophic. See also dystrophic, oligotrophic.

Miocene Epoch. The interval within the Tertiary Period (and the associated geologic strata deposited during that interval), from the end of the preceding Oligocene Epoch (23.3 million years ago) to the start of the Pliocene

Epoch (5.2 million years ago). See also Oligocene and Pliocene epochs.

Mire. A wetland in which peat accumulates owing to limited rates of organic matter decomposition, such as a fen, bog, or moor. See also bog, dystrophic, fen, moor.

Mixed-grass prairie. Perennial grasslands that are dominated by grasses of intermediate heights (often from 1.5-3 feet tall at maturity). See also shortgrass prairie and tallgrass prairie.

Monocot. Refers to a group of vascular plants (monocotyledons) that are characterized by having narrow, parallel-veined leaves, a single embryonic leaf within the seed, and flower parts usually consisting of threes or their multiples. Common examples include lilies, rushes, grasses and sedges. See also dicot.

Moor. An area of usually elevated but poorly drained land, typically of limited soil fertility and with many heaths (Ericaceae) and accumulated peat. See also mire.

Moraine: Gently rolling landscapes of glacial drift deposits, laid down at a glacier's lateral or terminal margins. See also drift, till.

Mollusca. A phylum of mostly aquatic invertebrates (mollusks) whose bodies are usually protected and supported by an external calcareous shell. The common mollusks of Nebraska wetlands are bivalves (mussels) and univalves (snails).

Naiad (pl., naiades). Refers to (1) the aquatic larval stages of dragonflies, mayflies and some other similarly metamorphosing insects, and (2) the freshwater mussels of the family Unionidae.

NCRS. Acronym for the U.S. Dept. of Agriculture's Natural Resources Conservation Service, previously known as the Soil Conservation Service(SCS).

NDNR. Acronym for the Nebraska Department of Natural Resources, the state agency charged with protecting the state's environments, including its surface waters.

Neotropical migrants. Refers to those migratory birds that winter in the Neotropic Region, namely south of the Tropic of Cancer. Some of these are additionally trans-equatorial migrants, wintering south of the Equator.

Niche. The behavioral, morphological and physiological adaptations of a species to its habitat. Sometimes defined from an environmental standpoint, such as the range of ecological conditions under which a species potentially exists (fundamental niche), best survives (preferred niche), or actually survives (realized niche). See also habitat.

Notostraca. An order of branchiopod crustaceans that includes tadpole shrimps, which are common in freshwater wetlands. See also Branchiopoda, Crustacea.

Nymph. The aquatic larval stage of some insects, such as dragonflies. See also naiad.

Ogallala aquifer. The principal aquifer of Nebraska, comprising Miocene, Pliocene and Pleistocene deposits of saturated sand and gravel, with a shale substrate. It is usually considered to include most or all of the High Plains aquifer, which extends from South Dakota south to Texas and New Mexico, and is one of the world's largest aquifers. See also aquifer, groundwater reservoir.

Oligocene Epoch. The interval within the Tertiary Period (and the associated geologic strata deposited during that interval), extending from the end of the Eocene Epoch (35-37 million years ago) to the start of the Miocene Epoch (23.3 million years ago).See also Cenozoic Era.

Oligotrophic (or ombrotrophic). Refers to waters poorly supplied with plant nutrients. See also dystrophic, eutrophic, minerotophic.

Order. A taxonomic category below that of a class and above that of a family.

Ostracoda. A subclass of crustaceans (ostracods) that are often called seed shrimps, and are usually common in freshwater wetlands. See also Crustacea.

Oxbow. A cut-off and isolated segment of a river, with standing rather than flowing water.

Paludology. The study of marshes.

Palustrine. Describes marshes and marsh-like wetlands such as wet meadows, seeps, fens, bogs, playas and prairie potholes. See also lacustrian, marsh, riparian.

Paleovalley. A valley of the geologic past, often buried under more recent sediments. Paleorivers are associated extinct rivers.

Passerine. A bird species that is part of the songbird assemblage (order Passeriformes), an avian group comprising roughly half of all living bird species. All other birds are collectively called non-passerines.

Peat. Partially decomposed plant materials that have accumulated over long periods under conditions of waterlogging, and are associated with fen and bog communities. Peatlands (fens and bogs) form wherever drainage is impeded and anoxic conditions prevail.

Pelecypoda. A class of bivalve (two-shell) mollusks (pelecypods), that includes clams and mussels, which are common in freshwater wetlands.

Perched lake. A lake with no groundwater connection, owing to a substrate with low permeability, so that its water level is unrelated to the groundwater reservoir. See also groundwater lake.

Periphyton. See algae.

Perennial. In botany, a plant that continues its life cycle from year to year indefinitely. The above-ground parts of perennial herbs and grasses may die back each year at the end of the growing season, but are replaced with new growth the following season. Among shrubs and trees the leaves may fall off, but above-ground buds persist. Biennials species are those species typically flowering and dying after their second year. Perennial wetlands are those sites that are permanently wet. See also annual, herbaceous.

Phreatophyte. Descriptive of plants having high water requirements, typically growing only near a steady source of water. By comparison, xerophytes require very little water to survive.

Phylum. One of the largest subdivisions of the plant and animal kingdoms.

Plankton. Microscopic-sized aquatic plants (phytoplankton) and animals (zooplankton) that typically move passively in aquatic ecosystems (plankton means "drifters") and are important parts of wetland food-chains.

Playa. A shallow, usually temporary, wetland occurring in a shallow soil depression and depending on surface precipitation for periodic recharge. Many Nebraska playas occur on loess or clay substrates south of the Platte. Alkaline wetlands in the western Sandhills resemble loess playas in exhibiting high average alkalinity, high sodium and potassium concentrations, and high carbonate or bicarbonate levels. They also exhibit marked seasonal and local variations in alkalinity, and associated algal and invertebrate populations. See also alkalinity, salinity.

Playa Lakes Joint Venture. A regional consortium of agencies, non-governmental organizations and landowners that was established in 1992 to improve migratory bird habitats in the Great Plains playa lakes region, from northwestern Nebraska south to western Texas.

Pleistocene Epoch. The interval extending from about 1.8 million years ago (the end of the Pliocene Epoch) to 11,000 years ago (the start of the current Holocene or Recent Epoch).

Plankton. Microscopic-sized plants (phytoplankton) or animals (zooplankton) living in water, including both pelagic forms adapted to living in suspension (euplankton) and those adapted to an attached existence (pseudoplankton or tychoplankton).

Pliocene Epoch. The interval (and associated geologic strata deposited during that interval) extending from the end of the preceding Miocene Epoch (5.2 million years ago) to the start of the Pleistocene Epoch (about 1.6-1.8 million years ago).

Pothole. A popular name for small wetlands in the glaciated region of the northern Great Plains, where wetlands are scattered over some 30,000 square miles at densities as high as 73 per square mile. The same word is used in geology to describe cavities in rocks excavated by water. See also slough.

Prairie. A native plant community dominated by perennial grasses. Prairies may be broadly classified by the relative stature of their particular dominant grass taxa (tallgrass, mixed-grass, or shortgrass), or by the characteristic form of these grasses (e.g., bunchgrasses or sod-forming grasses). More specifically they may be described by their dominant species or genera. Prairie soils are usually rich in organic matter, calcium and other nutrients.

Quaternary Period. The last 1.6 million years of the earth's history, including the Pleistocene and Holocene epochs. See also Holocene Epoch, Pleistocene Epoch.

Recent Epoch. Refers to the current geological epoch, from the end of the Pleistocene (ca. 11,000 years ago) to the present time; also called the Holocene Epoch. See also Holocene Epoch, Pleistocene Epoch

Refugium (pl. refugia). An area or region where one or more species have survived over long periods of unfavorable environmental conditions. See also relict.

Relict. A species or group that is now geographically isolated from others of its type, owing to past changes in climate or ecological alterations. Relicts are often associated with local climatic or topographic refugia. See also refugium.

Riparian. Wetland communities associated with flowing waters (lentic environments), such as rivers and their floodplains. Floodplain forests or riverside shrublands are common types of riparian communities in otherwise non-wooded habitats. Riverine is a synonym. See also gallery forest, lacustrine, lentic, palustrine.

River. A flowing-water (lentic) habitat in which water moves horizontally within a surface channel that typically has been variably modified by eroding and depositional actions of the water itself. See also brook, creek.

Riverine. See riparian.

Rotifer. A group of microscopic-sized invertebrates that are very common in wetlands. They are sometimes considered part of the roundworm phylum Aschelminthes, but usually are now accorded recognition as a unique phylum Rotatoria.

Rush. Herbaceous plants (family Juncacaceae) that are grass-like, with parallel-veined leaves, round, jointless and solid stems, and reduced three-part flowers. Commonly found in moist habitats. See also grass, sedge.

Salinity. The concentration of total dissolved solids in a water column. Saline wetlands may range (under increasing degrees of salinity) from fresh through oligosaline, mesosaline, polysaline and eusaline to hypersaline. Wetlands falling into the three categories from oligosaline through polysaline are termed brackish. See also alkalinity.

Savannas. Predominantly grassland communities in which trees are present but widely spaced. See also forests, woodlands.

Sedge. Herbaceous, grasslike plants (family Cyperaceae) having triangular, jointless and solid stems, parallel-veined leaves arranged in three ranks, and small seeds and flowers borne on spikes. See also grass, rush.

Seep. A wetland produced where an aquifer reaches the landscape surface and emerges (an artesian aquifer). Depending on the rate of discharge, seeps may produce stillwater pools or flowing streams. With limited nutrient availability, seeps may develop into fens or bogs. See also aquifer, bog, fen.

Shrub. A woody plant that is typically less than 12 feet (five meters) tall at maturity and usually has many aboveground stems. Shrub wetlands are those dominated by woody vegetation of shrub size, either as successional stages to forested wetlands, or as relatively stable communities. In northern peatland bogs (muskegs) spruces and tamaracks are common tree components.

Shrubland. Communities with a shrub layer of more than 25 percent canopy cover and trees of less than 25 percent

canopy cover. See also forest, tree, woodland.

Silt. Sedimentary materials intermediate in size between sand and clay. Wind-blown silt deposits form loess soils. See also loess.

Slough. A local name for small wetlands in the glaciated region of the northern Great Plains. See also lagoon, pothole.

Snag. A dead tree, still standing on land or partly submerged in water.

Species. A "kind" of organism, or, more technically, a population whose members are reproductively isolated from all other populations, but are capable of breeding freely among themselves. The term is unchanged in the plural, and also used as the taxonomic category below that of the genus and above that of the subspecies (abbreviated sp., plural spp.). The species' name occurs as the second (specific) component of a binomial Latin or Latinized name (after the generic name), and is never capitalized. See also genus.

Stream. A wetland environment flowing within a natural channel of the land surface, from small brooks to large rivers. See also brook, river.

Subspecies (abbreviated ssp., plural sspp.). A geographically defined and recognizable (by morphology, genetics or behavior) subdivision of a species. In a scientific name, subspecies designations follow the species' epithet, and comprise the last component of a three-part or trinomial name. See also species.

Succession. The series of gradual plant and animal changes that occur in biotic communities over time, as relatively temporary (successional or seral) taxa are sequentially replaced by others that are able to persist and reproduce for a more prolonged or indefinite period ("climax" species). See also community.

Swale. A wet meadow, or moister lowland parts of am otherwise dry meadow. See also meadow.

SWCP. Acronym for the Saline Wetlands Conservation Partnership, a group dedicated to the protection and preservation of Nebraska's eastern saline wetlands.

Swamp. A temporarily or permanently flooded woodland or forest. Swamps in Nebraska are caused by impoundments and are relatively temporary; no native Nebraska trees can survive long when flooded. Flooding leaves standing snags that eventually decay. See also marsh, snag.

Swampbuster & Sodbuster laws. Components of the 1985 U.S. Dept. of Agriculture's Farm Bill, designed to reduce the rate of conversion of wetlands (Swampbuster provision) and highly erodable croplands (Sodbuster provision) to crop production.

Sympatric. Populations that overlap at least in part, especially during the breeding season. By definition, sympatrically breeding but non-interbreeding populations are considered separate species. See also species.

Tallgrass (or "true") prairie. Perennial grasslands that are relatively well-watered and are dominated by tall-stature grasses, often more than six feet (two meters) tall at maturity. See also shortgrass prairie and mixed-grass prairie.

Tertiary Period. The first of the two major subdivisions of the Cenozoic Era, beginning about 65 million years ago (at the end of the Cretaceous Period) and lasting until about 1.8 million years ago (the start of the Quaternary Period). See also Paleogene and Neogene periods.

Thermal stratification. The layering of lake water, caused by temperature-related variations in water densities. The thermocline zone of a stratified lake is the zone of most rapid temperature change.

Threatened. Descriptive of taxa that have declined and exist in small numbers, but are not yet so rare as to be classified as endangered. Somewhat similar in meaning to "vulnerable," or "declining," which are terms used by some conservation agencies to refer to taxa in need of conservation measures in order to prevent a more critical status.

Till. Unsorted glacial drift. See also drift.

Tree. A woody plant that is usually well above twelve feet (five meters) tall at maturity, and typically has a single main stem. See also shrub.

Trophic levels. The successive production and consumption levels in a food chain. Trophic levels also are applied to wetlands, based on plant nutrient availability, with categories ranging from oligotrophic (few available nutrients), mesotrophic (intermediate nutrients) to eutrophic (high nutrient levels). Bogs are sometimes characterized as dystrophic (with relatively unavailable nutrients, owing to an acidic pH, unfavorable oxidation–reduction ratios, and slow rates of organic decomposition).

Vernal pond (or pool). An ephemeral wetland produced by melting snow or spring rains. See also playa.

Warm-season grasses. Grasses adapted to grow and mature during warmer periods.

Water table. The zone of a saturated substrate that begins where the water pressure equals the atmospheric pressure, producing the upper boundary of an underground reservoir of water, or aquifer. See also aquifer, ground water, groundwater reservoir.

Watershed. An area or region that drains a river system, stream or body of water.

Wet meadow. A meadow that is subirrigated by a water table close enough to the surface so that plant roots are in contact with it throughout the growing season. See also meadow.

Wetland. A water-dominated environment in which impounded water is present, or where the substrate is water-saturated long enough to support plants adapted for life under water-saturated soil conditions. Wetlands commonly are defined as including marshes, swamps, seeps, bogs, fens, wet meadows and transitional shoreline or floodplain communities. Shallow wetland marshes in the northern Great Plains are popularly called "potholes" or "sloughs." Nebraska's Rainwater Basin seasonal playa wetlands are often locally called "lagoons." See also bog, fen, lake, marsh, mire, playa.

WHIP. Acronym for the Dept. of Agriculture's Wildlife Habitat Incentives Program, initiated in 1996 and designed to assist landowners with habitat restorations benefiting fish and wildlife.

WRP. Acronym for the Dept. of Agriculture's Wetland Reserve Program, a federal program initiated by the 1990 Farm Bill, and designed to provide incentives to landowners for restoring long-term function and value to degraded wetlands in agricultural landscapes.

WREP. Acronym for the Dept. of Agriculture's Wetland Reserve Enhancement Program, initiated in 2010 to enhance conservation effectiveness on wetlands and adjacent lands.

Woodlands. Partly wooded communities in which the height of the trees (over five meters high) is usually less than the distances between them, so that the overhead canopy is discontinuous (25-60 percent canopy cover). The non-technical term "woods" or "wooded" is often used to include both woodlands and forests. See also forests, savannas.

Xeric. Desert-like or drought-adapted, such as the xerophytic vegetation of arid lands.

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Geographic Index

Note: Most index entries are limited to the principal account for each site or region. NWR refers to national wildlife refuges. SRA to state recreation areas, WMA to wildlife management areas, and WPA to waterfowl production areas.

Taxonomic Index

Note: Pages with illustrations of species are indicated by italics; extended descriptions are indicated by **boldface**. Most of the bird entries are limited to those pages indicating ecological associations or providing quantitative information. The appendices are not indexed.

Vertebrates

Invertebrates

Plants